POWER

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What a Depressed Business Period Means to the Power-Plant Engineer

THERE follow some suggestions the power-plant engineer may study to advantage in times like the present when, in many lines business is less brisk than usual:

Likely, the management is trying mighty hard to cut expenses and is working more strenuously than ever to get business. It is going the limit in extending credit to those of its patrons that need it. It is willing to do business at a smaller profit than has for many years been its practice – anything to get business, to keep going, to hold its valuable labor, its trusted salaried men, and not suffer too great a loss in doing so.

The "Old Man," be he president, manager or superintendent, is in the mood that such conditions produce. He is probably putting in trying hours with his bankers, auditor, sales and advertising and production managers. He is busy – thinking.

If your plant is running at full tilt, you are indeed fortunate. Likely it is not. So there is time for you to think too. Use time that way. Scout around the plant, search as you never searched before for means of producing power at lower cost than the plant has ever produced it. Take note, with pencil and paper, of the ideas that come to you in the search. There will be many – more than you can remember when you have finished. Take each operation separately; follow it through from beginning to end.

Just a few suggestions: Could you use a cheaper fuel, or a combination of coals that would lower the cost of evaporation per thousand pounds of steam? Can you simplify handling or more expeditiously handle the coal and ashes? Are you sure the fuel is more suited to the furnace and grate or stoker than other coals available at no greater cost? Can you not provide for weighing it and measuring the water used so as to have a means of checking the evaporative qualities of the fuel? Is every wasteful air hole in the furnace and breeching plugged? Are you sure that the arrangement of the baffling in the boilers is in accordance with what the latest practice has demonstrated to be best? From the condensate, of which there is proportionately so much more when the plant is loafing along, are you getting back every B.t.u. possible? Look into this carefully. And valves; how many on high-pressure lines are leaking? Regrinding or renewal of seat rings and discs on many would pay well. How long since you indicated the engine and compressors? To do so now might tell a story that would surprise you. In lubrication; if you use a quart of oil too much per week, it's your fault; if you throw any away through failure to filter it for use over and over again, you are wasting a costly supply. Those small reciprocating pumps, and the centrifugals too, they're heavy consumers of steam; can you cut their use of it by keeping them in service less hours per day? Then there's the loss of power in transmission through the mill or factory. Go over the belts, pulleys, etc. Process steam – what departments are wasting it?

These are but a few of the items you will encounter in the survey. A critical examination of every detail will show where new equipment of the fuel-saving and labor-saving kind may be profitably installed You now have the time to consider their worth, to gather convincing reasons for their purchase to accompany your requisitions for them. And the survey will likely show that there are many things about power engineering you don't know as thoroughly as you thought you did.

The "Old Man" will be delighted to get a report of the results of your survey. Tell it in language he understands. It will show him that you are alive to the situation that confronts *him*.

Business will probably soon be back to normal. It is now back in some lines. Your management will then be ready to spend the money it is now reluctant to spend because it cannot see just what is ahead. And when that time comes—and it is not far off—the "Old Man" will see that you get what you need, for you will have interested him and gained his confidence.

Get that pad and pencil!

Acme Power Plant At Toledo

A 200,000-kw. ultimate capacity generating station, of which 40,000 kw. in two units has been installed. Prominent features of the station are the coal handling, the water supply, a well-designed boiler room with unusual facilities for metering and control and a switchhouse designed for convenience and safety.

DUE to its industrial growth and the increasing needs of its street-railway and interurban systems, Toledo for years has been approaching the limits of the power stations of the Toledo Railways and Light Co. A new station, favorably located and with plenty of room for expansion, was badly needed. Eventually, the Acme Power Co., a Doherty subsidiary,

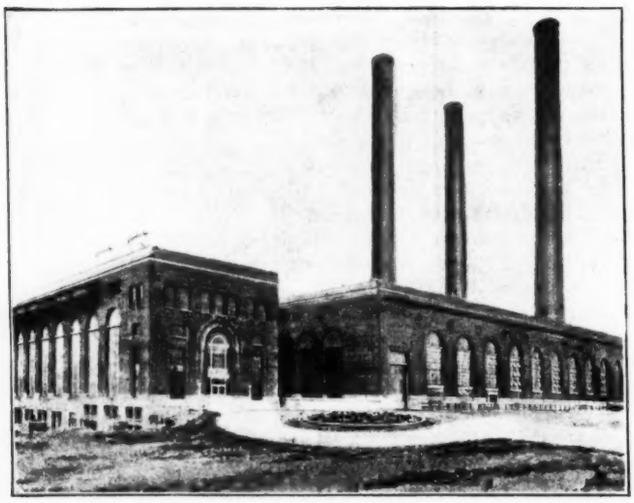

FIG. 1. NEW BRICK STATION OF ACME POWER CO.

laid out such a plant for an ultimate capacity of 200,000 kw. in ten units, each to consist of a 20,000-kw. turbo-generator, served by four boilers having steam-making surface approximating 14,000 sq.ft. About three years ago the first of these units was installed and the second has been in operation nearly a year, but as construction was delayed in some of the appointments of the plant, information on the general design is only now available. Succeeding units may have a capacity of 30,000 kw. The general layout will permit such an increase over the original plan. Although a distinct organization, the company supplies its entire output to the Toledo Railways and Light Co.

An old rolling-mill site of 43 acres on the east bank of the Maumee River was chosen for the plant. It has the river to draw on for condenser circulating water and boiler feed, is served by a spur of the Pennsylvania Railroad and is in near proximity to the Hocking Valley Railroad yards.

As the output of the plant was to be sold at a relatively low charge, high economy and operation with the least amount of labor were the primary considerations in the design. An analysis of the labor situation for the present installation of 40,000 kw., which includes two generating units and eight boilers, shows that eight men per shift are required to operate the plant. The force consists of an engineer in charge of the shift, a boiler-room engineer, turbine-room engineer, stoker operator, switchboard operator, two boiler-room helpers and an oiler for auxiliary apparatus. In addition to this force, six men on one shift are required to handle the coal and ash and there is a maintenance force and additional employees in the office of the company.

Fig. 1 shows the plant buildings which are constructed of brick with concrete foundations and trimming. The building at the left is the switchhouse, containing also general offices of the company, and the larger building at the right houses the boilers and turbines. On the dock at the river bank there is a screenhouse and at the entrance of the property a small gatehouse. For the help in the various departments shower baths, toilets and locker rooms have been provided, and as a part of the office suite a temporary operating room has been equipped with all essentials. An elaborate system of records and cost accounting has been established.

Arrangement of Boilers

In the boiler room eight boilers, aggregating 113,240 sq.ft. of steam-making surface, have been installed, an allowance of 2.83 sq.ft. per kilowatt of generator rating. They are arranged four in a row and crosswise of the boiler house, facing a central aisle as indicated in Fig. 2. As additions are made to the plant, similar units of four boilers will be installed in the same way. Fig. 3, a sectional elevation, and Fig. 4, a plan view, show the general arrangement, the flue connections of the individual economizers and the piping layout. The boilers at the left of the firing aisle in Figs. 2 and 3, are of the vertical, water-tube type containing 13,750 sq.ft. of steam-making surface. The other four boilers at the right are of the horizontal cross-drum marine type having 14,560 sq.ft. of surface. These boilers are vertically baffled for three passes of the gases, and in both types the gas outlet is to the rear where the gases pass through individual economizers on the same level as the boilers or through a bypass to the smoke flue leading to the stack. Each type of boiler is equipped with a superheater, as indicated. A superheat of 150 deg., combined with a working pressure of 250 lb. gage, gives a steam temperature of 556 deg. F.

The boilers are suspended from the building steelwork. The settings are of firebrick and lined with insulating brick. Ample spacing is provided around the boilers, as the firing aisle is 26 ft. 4 in. wide and the distance between individual boilers ranges from 12 to 27 ft. In the case of the horizontal boilers the bottom of the front tube header is 12 ft. 6 in. from the floor, allowing a furnace volume approximating 3,000 cu.ft. A furnace volume one-third greater has been obtained with the vertical boilers. As normal operation is to be in the vicinity of 200 per cent of rating, requiring about 10,000 lb. of Ohio coal per hour, the figures just quoted reduce to 0.3 and 0.4 cu.ft., respectively, per pound of coal burned per hour. This allowance is above the average and should permit of exceptionally high combustion efficiencies. The coal averages 11,000 B.t.u. per lb. contains ash to the amount of 15 per cent and over 2 per cent of sulphur.

Both types of boiler are served by underfeed stokers, the vertical boilers having 16-retort, 17-tuyere stokers with a total projected grate area of 256 sq.ft. Under the horizontal boilers are 15-retort, 22-tuyere stokers having a projected grate area of 287 sq.ft. To these figures the steam-making surface bears a ratio of 53 and 51, respectively. Both types of stoker are equipped with steam-power dumps which deliver to ashpits discharging into railway cars at grade through air-operated gates. Each stoker has an individual motor drive with hand rheostat control. To give a wide range of speed, 4 to 1 direct-current motors are employed.

Each boiler has its forced-draft fan and an induced-draft fan on the stack side of the economizer. The ter may draw temporarily on the storage battery of the plant, which is of the lead-plate glass-jar type having 400 ampere-hour capacity. This provision is of particular value in bringing up the boilers should the entire plant be down.

On the individual control board just referred to, there are numerous instruments giving all necessary operating data, the board being located at the front and to the side of its respective boiler, so that it will be in constant view of the fireman. As all boilers have double steam outlets, the equipment consists of two steam-flow meters with additional recording pens. The extra pen on one meter records the air flow through the boiler and on the other the pounds of coal fed to the

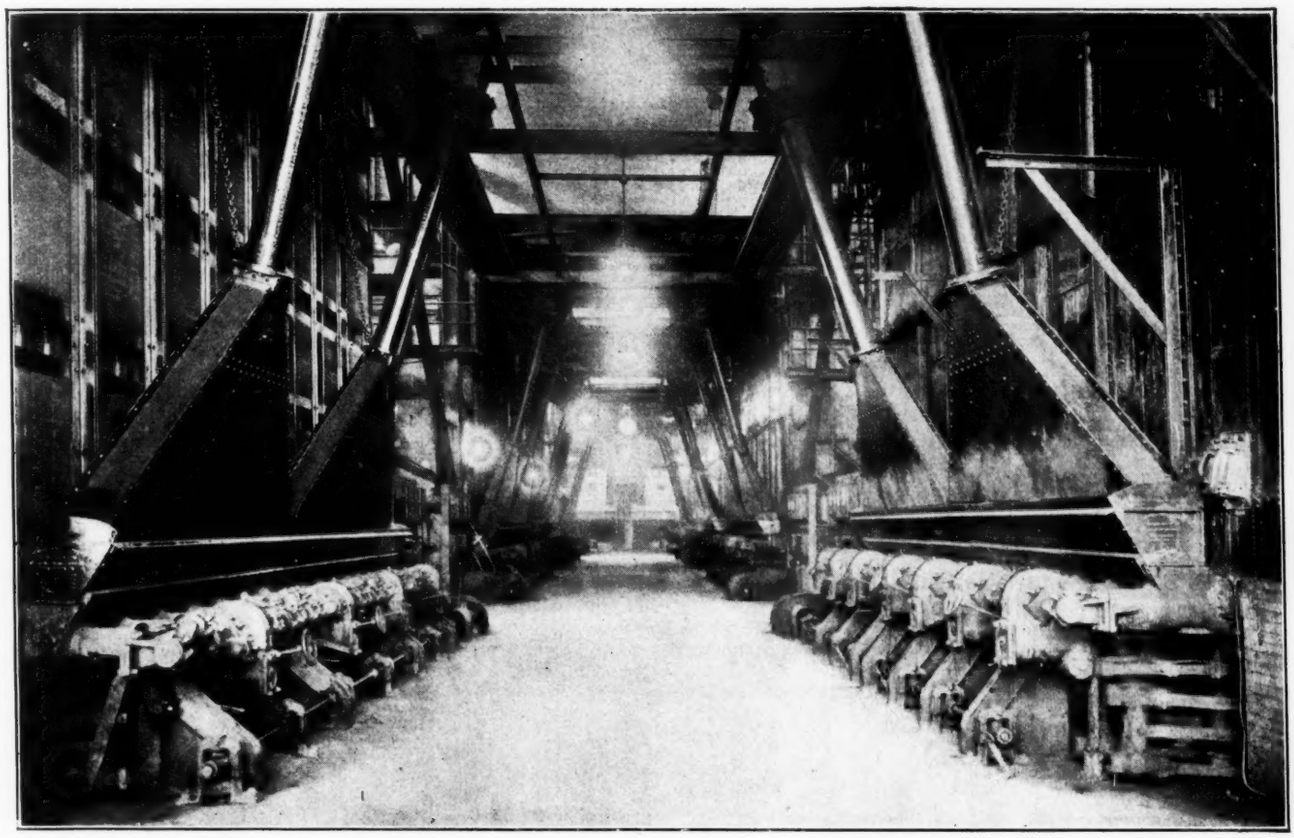

FIG. 2. CENTRAL FIRING AISLE BETWEEN FIRST TWO BOILER UNITS

former are located on the basement floor in a sealed room receiving the generator cooling air. All four fans for each row of boilers discharge vertically into a common duct, with a dampered outlet to the windbox of each stoker and dampers in the main duct so that the fan may be limited to its respective boiler or supply other boilers of the unit if it is desirable. Both the forced- and induced-draft fans are driven by slip-ring induction motors with liquid rheostat control, which for the fans give a satisfactory range of speed, although not as great as that obtained with the stoker motors. The control of the liquid rheostat is effected by means of pushbuttons on individual boiler control boards. All the motors driving fans and stokers are provided with spare cables and oil switches so that if anything happens to the main circuit, the motor may be cut over onto the emergency line. There is also duplication in the source of supply for the stoker motors, as the lat-

stoker, as well as the wind-box pressure. In three of the boilers coke-oven gas is burned when it can be obtained, the gas being introduced through the bridge wall and the stokers covered with ash for protection. On one of the flow meters serving each of these boilers an extra pen is provided to record the quantity of gas used. A second check on the coal weight is obtained by means of a counter on the stoker which indicates the number of strokes made by the feeding rams. To obtain the stoker constant, different grades of coal require a calibration of the rams. In addition the coal is weighed on a weightometer in the crusher house as it passes to the bunkers. The monthly total is compared with the boiler records plus the amount of coal remaining in the bunkers, so that an error of any magnitude will be discovered.

Another instrument on the control board is a four-pen recording thermometer which gives the tempera-

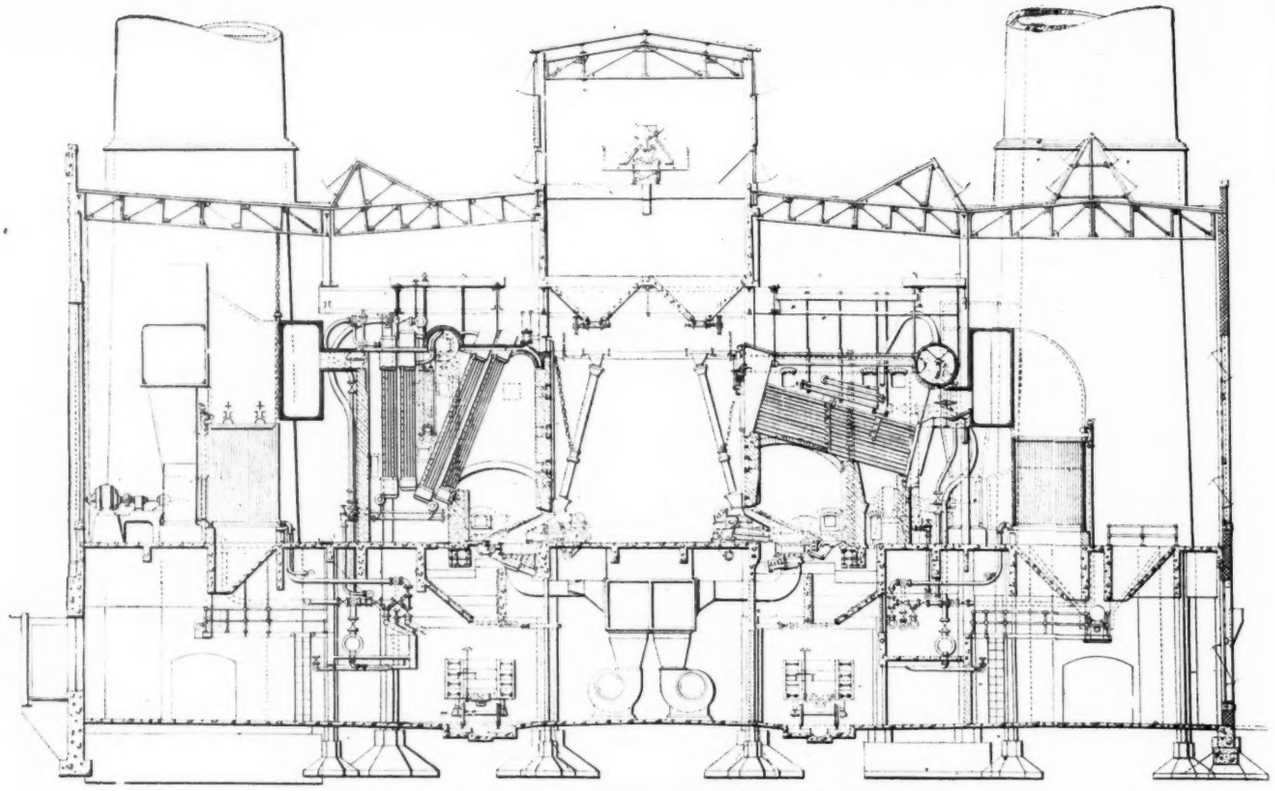

FIG. 3. TRANSVERSE SECTION THROUGH BOILER ROOM

tures of the gas entering and leaving the economizer and of the water to and from the economizer. There are ammeters for the fan and stoker motors and two three-in-one gages indicating the draft over the fire, at the uptake, at the entrance and outlet of the economizer, at the stack and the windbox pressure.

Reference to Figs. 3 and 4 will show the flue connections to the economizers and the provision for bypassing an economizer when desirable. The economizers are of the high-pressure cast-iron type, containing 7,730 sq.ft. of surface in 480 twelve-foot tubes of 4½-in. outside diameter, arranged in 40 sections, 12 tubes wide. The water capacity is 37,100 lb. In operation it is the plan to give the economizers a

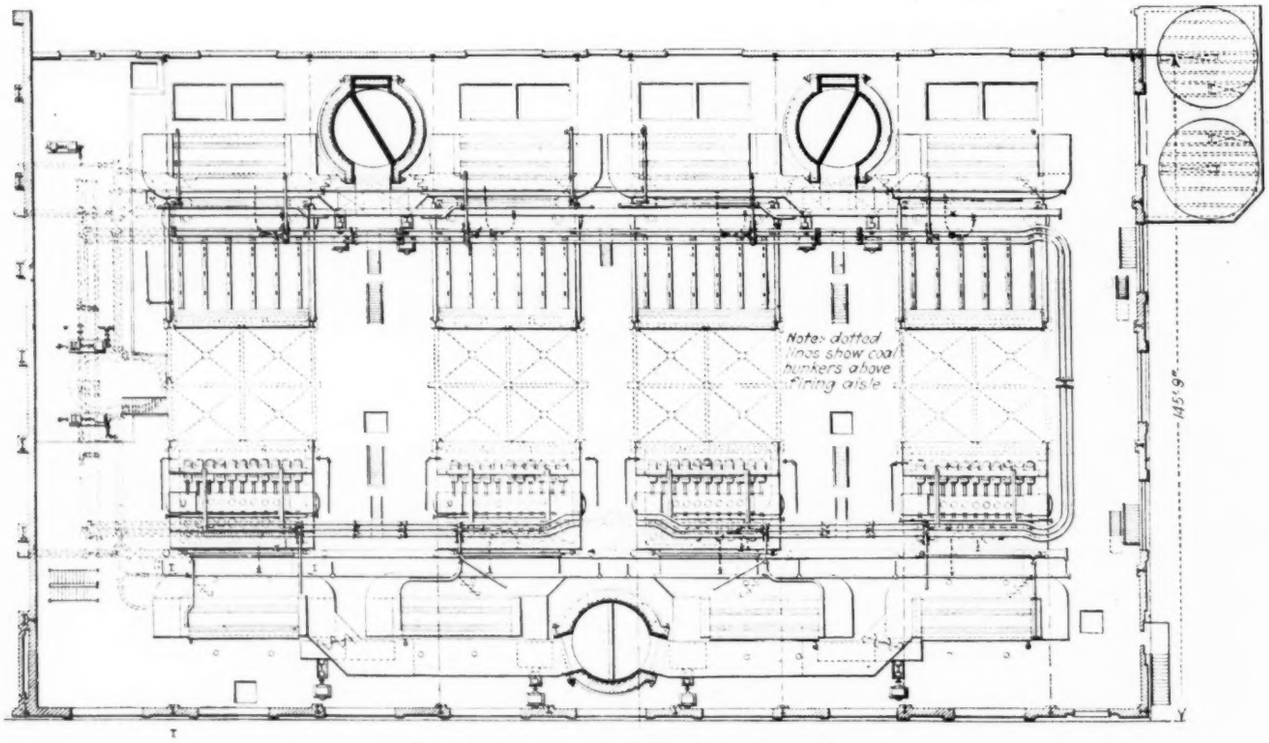

FIG. 4. PLAN OF PRESENT BOILER ROOM

wide operating range. The feed water is introduced at about 150 deg. and taken out at 230 deg. Depending upon the load carried by the boiler, the gases enter at 550 to 600 deg. F. and leave the economizers at 350 to 400 deg. The draft drop between the stack and the uptake of the boiler through the economizer averages about 0.4 in. of water.

Soot from each economizer is blown into a pit underneath and is removed by a steam-jet conveyor, there being a 4-in. system for each row of boilers. Two connections are made to each stack, and once a week soot from these two sources is removed and discharged to the ash hoppers of Nos. 1 and 8 boilers below the sprinkling line.

In the plan view, Fig. 4, it will be seen that one stack is provided for four boilers. For the first unit the stack is located centrally, with two boilers on either side and a division wall at the center of the stack to prevent interference. For the second unit of boilers one stack serves two boilers of each unit, the stack being located centrally in respect to the four boilers and each half receiving the gases directly from a boiler on either side. This arrangement shortens the length of the smoke flue, but necessitates a right-angle turn into the stack. The stacks, which are of radial-brick construction, are supported by concrete foundations resting on concrete piers which go down to hardpan about 60 ft. below the surface. The effective height of each stack is 275 ft. and the diameter at the top, 14 feet.

Steam and water piping for the boilers is concentrated in pipe galleries below the boiler-room floor. A 20-in header serves each row of boilers. Both headers receive two 8-in. lines from each boiler, and at the end of the boiler room there is a 14-in. cross-connection with a circular expansion loop. The headers are mounted on rollers and anchored rigidly at the turbine-room wall, at which point each header reduces to 16 in. in diameter and continues to the respective turbine of the unit. An auxiliary 8-in. header with three 5-in. taps supplies the various steam pumps in the station.

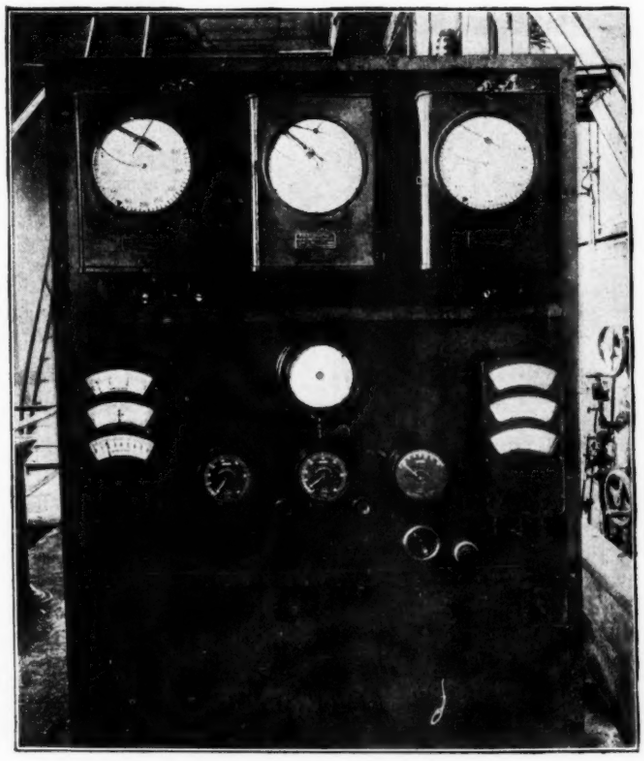

FIG. 5. INDIVIDUAL BOILER-CONTROL BOARD

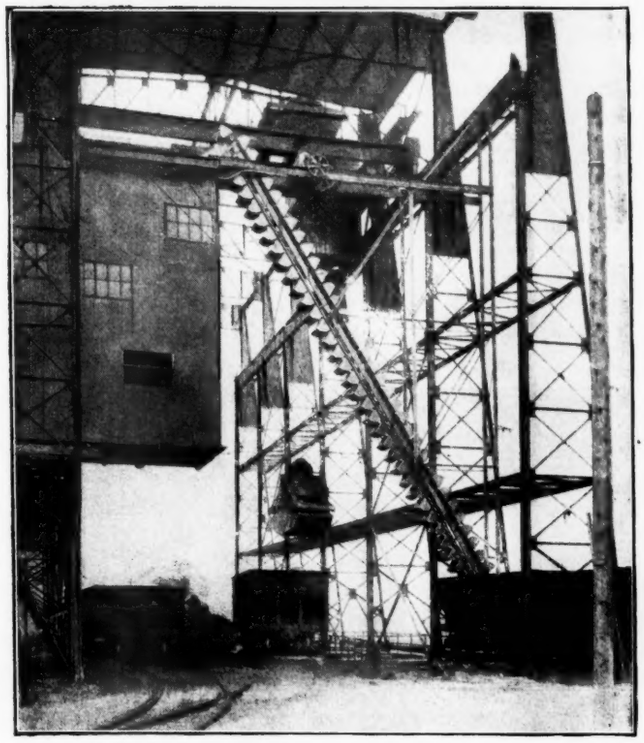

FIG. 6. COAL-HANDLING MACHINERY

About 95 per cent of the boiler-feed water is condensate. It is pumped to metering tanks on the third balcony at the end of the boiler room, which discharge to a condensate and makeup water surge tank. All water used for bearing and transformer cooling is taken from the tunnel supplying the condensers and pumped through sand-pressure filters to a large concrete house-supply tank on the basement floor of the boiler room. The hot return cooling water from the bearings and transformer is brought back and stored in two large concrete supply tanks in the boiler-room basement. From these two latter tanks the water for makeup and other requirements that do not require cold water are taken. Water intended for makeup for boiler feed is next passed through an intermittent purifying plant and treated with lime, soda ash and iron sulphate, as the river water has hardness, acid and foreign matter which must be neutralized. Open sand filters remove the sludge and the water passes to two large receivers, from which it is pumped to an overhead pressure tank that stores the water for boiler makeup. From this tank the water flows by gravity to a metering makeup tank in which it is measured before passing on to the condensate storage tank previously mentioned. To this tank there is also a connection for city water under emergency float-valve control.

Water from the surge tank flows through a V-notch meter to either one of two open heaters on the second gallery, each having a capacity of 500,000 lb. of water per hour. The location of the heaters gives an 18-ft. head on the boiler-feed pumps installed on the first gallery. There are three of these pumps, steam-turbine driven, two rated at 1,000 gal. per min. and one at

1,500 gal. per min. The pumps may discharge into either one of two 8-in. ring headers serving the boilers. The economizers may be utilized or bypassed. Two 4-in. lines lead up to either side of a boiler and each has a feed-water regulator. A hydrostatic test line of ring design is also provided. On the second balcony and at the same level as the feed-water heaters are weighing tanks for boiler testing. In addition to the feed pumps on the first balcony there are five service pumps, four of which are motor-driven and one driven by a steam turbine.

Coal comes to the plant by rail into a yard having a capacity for about 50 cars, served by an electric locomotive. The coal is unloaded into the comparatively small dry pocket, which for the present plant capacity holds about 3,000 tons of coal divided up into bays of about 500 tons each. A traveling crane with a 3-cu.yd. bucket lifts the coal from this pocket into the crusher house, set about 68 ft. above the ground on the steelwork of the coal-handling equipment. When traveling from the end of the dry pocket to the crusher house, the crane has a capacity to handle about 150 tons of coal per hour. After the coal is reduced to the proper size by a 2-roll toothed crusher, it is carried to the overhead bunkers in the boiler house on a 24-in. rubber conveyor belt equipped with a traveling belt-propelled unloader. While on the belt, the coal is weighed by a weightometer designed to perform its function while the coal is in motion.

As indicated in Fig. 3, the bunkers are supported over the central firing aisle, being four in number with a capacity of 300 tons each. Thus the four bunkers have a capacity of 1,200 tons, which is sufficient to carry the present plant at full load for 30 hours. Each bunker serves a boiler on either side. It is of square design with pyramidal bottom. In case of fire or an emergency, a monorail crane has been provided in the bunker monitor for transferring the coal from one bunker to the other. It may be used also for handling material from the ground floor to any of the intermediate floors.

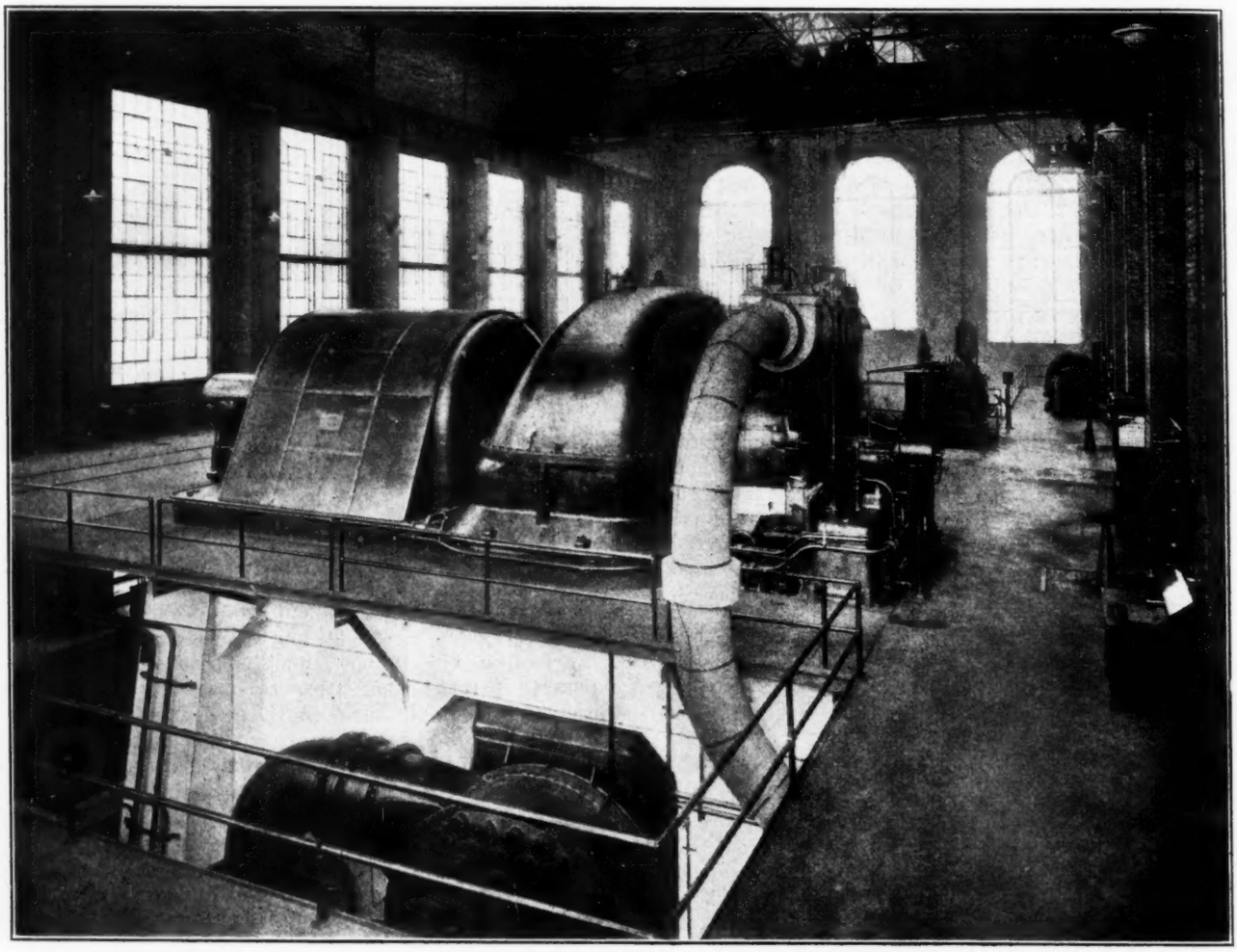

FIG. 7. TURBINE ROOM CONTAINING TWO 20,000-KW. UNITS

From the corner of the dry pocket to the crusher house an emergency outfit, consisting of a bucket elevator with a capacity of 50 tons per hour, has been provided. The elevator will take care of the coal in its immediate vicinity, but in case of necessity an emergency locomotive crane could pick up the coal from the other sections of the dry pocket and place it within reach of the bucket elevator.

Near to the dry pocket plans have been made for under-water storage. Ultimately, it is proposed to construct four pockets holding about 50,000 tons each,

in which the coal will be either totally submerged or partly, depending on the season. One of the pockets has been completed, but up to the present the storage has been dry. A traveling gantry crane serves this storage. It has a span of 160 ft., with a cantilever 20 ft. long, and is equipped with a 3-cu.yd. bucket. Eventually, there will be direct connection between the wet storage and the dry pocket, but at present the coal must be loaded into railway cars from the wet storage and switched over to the dry pocket to be handled in the same way as the incoming coal.

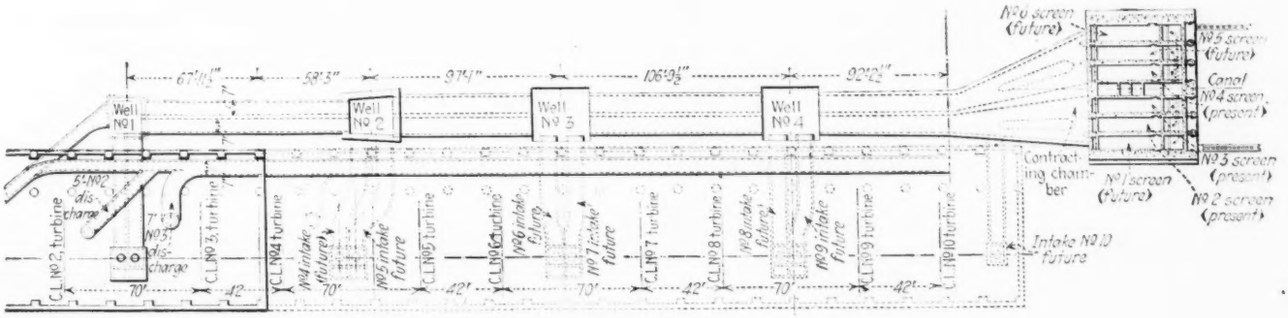

FIG. 8. LAYOUT OF WATER INTAKE AND DISCHARGE TUNNELS

Mention has been made previously of the equipment of the turbine room, which at present consists of two turbo-generators having a capacity of 20,000 kw. at 85 per cent power factor. One of the turbines is a 13-stage machine and the other, of Rateau type, has 23 stages. For the former the most economical point on the steam curve is 11.6 lb. per kw.-hr. at 15,000 kw. At full load the guaranteed steam consumption is 11.65. For the 23-stage turbine the guaranteed water rates are 11.25 and 11.5, respectively, these rates in either case with steam at 225 lb. gage pressure and 150 deg. superheat and a vacuum of 1½ in. absolute.

The generators of these units are 25-cycle three-

PRINCIPAL EQUIPMENT OF ACME POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Vert. water-tube	13,750 sq.ft	Generate steam	250 lb., 150 deg. superheat, forced and induced draft	Biglow-Hornsby
4	Boilers	Hor. cr. dr. water-tube	14,557 sq.ft	Generate steam	Coal- or gas-fired, forced and ind. draft	Babcock & Wilcox
4	Stokers	Taylor underfeed	16-retort, 17-tuyere, 256 sq.ft	Under B.-H. boilers	Dr. by Westinghouse 20 hp., d.c. motor, 300–1,200 r.p.m	American Eng. Co.
4	Stokers	Taylor underfeed	15-retort, 22-tuyere, 287 sq.ft	Under B. & W. boilers	Dr. by Westinghouse 30-hp. d.c. motor, 225–800 r.p.m	American Eng. Co.
8	Fans	Multivane blower	38,000 cu.ft. per min.	Forced draft	Dr. by 125-hp. Westinghouse slip-ring ind. motor, 720 r.p.m	Sturtevant
8	Fans	Multivane exhauster	60,000 cu.ft. per min.	Induced draft	Dr. by 110-hp. Westinghouse slip-ring ind. motor, 480 r.p.m	Sturtevant
8	Economizers	Pressure	7,730-sq.ft	One to each boiler	250-lb. press., water 150–230 deg.	Sturtevant
8	Superheaters	Foster	2,000-sq.ft	Serve boilers	150 deg. F. superheat	Power Specialty Co.
2	Heaters	Open	500,000 lb. per hr	Boiler feed	Exhaust steam	Harrison Safety Boiler Works
2	Pumps	3-stage	6-in., 1,000 g.p.m.	Boiler feed	Dr. by 260-hp. Kerr turbine, 2,300 r.p.m.	Janesville Iron Works
1	Pump	3-stage	8-in., 1,500 g.p.m.	Boiler feed	Dr. by 375-hp. Kerr turbine, 1,680 r.p.m.	Janesville Iron works
4	Pumps	Centrifugal	5-in., 1,000 g.p.m.	House service	Dr. by 30-hp. Westinghouse ind. motor, 1,450 r.p.m.	Lea-Courtenay
1	Pump	Centrifugal	5-in., 1,000 g.p.m.	House service	Dr. by 25-hp. Kerr turbine, 2,000 r.p.m.	Lea-Courtenay
1	Crane	Electric bridge	84-cu.ft	Dry pocket storage	Hoist coal from dry pocket to crusher	Brownhoist
1	Crane	Gantry	84-cu.ft	Wet pocket storage	Unload and reload storage coal	Brownhoist
1	Conveyor	Belt	30-in. wide, 640 ft. long	Coal from crusher to bunkers	Dr. by 20-hp. Westinghouse ind. motor	Robins
1	Elevator	U-bucket	24 in. wide, 65 ft. long	Coal from dry pocket to crusher	Dr. by 15-hp. G.E. ind. motor	Fairfield Eng. Co.
1	Crusher	2-roll	150 tons per hr	Crush coal	Dr. by 50-hp. Westinghouse ind. motor	Robins
1	Weightometer		150 tons per hr	Weighs incoming coal	Continuous operation	Merrick Scale Co.
1	Turbine	Curtis, 13-stage	20,000 kw	Main generating unit	225 lb., 150 deg. superheat, 1,500 r.p.m.	General Electric
1	Turbine	Rateau, 23-stage	20,000-kw	Main generating unit	225 lb., 150 deg. superheat, 1,500 r.p.m.	General Electric
2	Generators	A.C	20,000-kw	Main generating units	3-ph., 25-cycle, 6,600-volts, 1,500 r.p.m.	General Electric
2	Condensers	Surface	31,000-sq.ft	Serve main turbines	Motor and turbine-driven auxiliaries.	Wheeler Condenser & Eng. Co.
2	Pumps	Centrifugal	36-in	Condenser circulating	Double-drive, 265-hp. turbine and 250-hp. motor	Wheeler Condenser & Eng. Co.
4	Pumps	Centrifugal	8-in	Condensate	Two turbine dr. and two ind.-motor dr.	Wheeler Condenser & Eng. Co.
2	Pumps	Hurling water		Vacuum	Dr. by 90-hp. Kerr turbine	Wheeler Condenser & Eng. Co.
1	Steam jet	Three-stage		Aux. vacuum		Wheeler Condenser & Eng. Co.
1	Generator	D.C	1,091 amp., 250 v	Excitation and d.c. power	Dr. by 300-kw. turbine	General Electric
1	Generator	D.C	1,200 amp., 250 v	Excitation and d.c. power	Dr. by 750-kva. syn. motor	General Electric
2	Air washers	Nozzle spray	51,840 cu.ft. per min.	Wash generator air		American Spray Co.
1	Pump	Centrifugal	370 g.p.m	Water to air washer	Dr. by 10-hp. Allis-Chalmers motor	Dayton-Dowd
7	Transformers	Oil and water-cooled	6,000 kva	Step-up 6,600–23,000-v		General Electric
3	Screens	Traveling	72-in. wide, 50 ft. between centers	Condenser circ. water	Dr. by 5-hp. Westinghouse ind. motor	Link Belt Co.
1	Crane	Elect. bridge	6-motor, 100-ton	In turbine room	Span 77 ft., 6 in	Toledo Bridge & Crane Co.
2	Water softeners	Cold-process	50,000 g.p.h	Treat feed water	Lime, soda ash and iron sulphate	W. B. Scaife Co.
2	Conveyors	Steam-jet	4-in	Soot from economizers and stacks	High-pressure steam	American Steam Conveyor Corp.
1	Locomotive car	Electric	18-cu.yd	Coal and ash handling	550-volt trolley	Differential Car Co.
1	Crane	Locomotive	10-ton, 25-ft. radius	Storing coal		Ohio Locomotive Co.
3	Stacks	Radial-brick	Effective height, 275 ft.	Serve boiler units	Four boilers to one stack	M. W. Kellogg Co.

Diamond soot blowers, 14 element; 16 Copes feed-water regulators; Westinghouse switchboard; Precision draft gages; Bailey steam flow and temperature recorders; Bailet V-notch wier to measure condensate; Fairbanks test scales for weighing feed-water and coal; Simplex and Everlasting blow-off valves; Edwards stop and check valves; Lagonda non-return valves; Chapman venturi type high-pressure steam valves; Pratt & Cady l.p. steam and water valves; Squires steam traps.

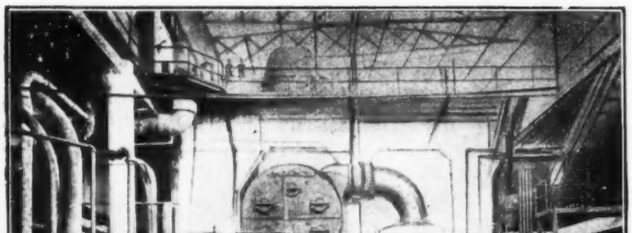

FIG. 9. CONDENSER PIT

phase 6,600-volt machines making 1,500 r.p.m. They are Y-connected with six leads brought out for the installation of current transformers for differential relay protection. Both units have direct-connected exciters.

Reference to Fig. 9 will show that the turbo-generators are mounted on heavy reinforced-concrete foundations within which are the surface condensers resting on spring supports. Each condenser has a surface of 31,000 sq.ft., reducing to 1.55 sq.ft. per kilowatt of generator rating, but 1,200 sq.ft. of this surface is contained in a heater section in the exhaust of the turbine for raising the condensate temperature to within five degrees of that corresponding to the exhaust-steam pressure. The auxiliaries consist of a circulating pump having a capacity of 40,000 gal. per min., which has a double drive consisting of a 265-hp. geared turbine and an induction motor of the same rating. The condensate pumps are in duplicate, one driven by a steam turbine and the other by an induction motor, while the air pump is of the hurling-water type driven by a steam turbine. For emergency use a three-stage steam-jet air pump has been installed between the two condensers and connected to both. It has a capacity of 45 cu.ft. of free air per minute at 28 in. of vacuum, being large enough to maintain a 20-in. vacuum on the two condensers at the same time. Another emergency provision is a 36-in. crossover connection from one circulating pump to the other, controlled by motor-operated valves.

Air for cooling the generators is drawn largely from the switchhouse through an inclosed passage giving communication between these two sections of the plant. An air washer having a capacity of 51,840 cu.ft. of air per minute is provided for each generator, and the spray curtain is formed by 270 nozzles supplied by a motor-driven pump.

In addition to the main units the turbine room has two exciter sets, one steam-turbine driven and the other driven by a synchronous motor. The latter unit is run almost continuously as it supplies a large part of the direct current for stoker drive and the coal crane motors. A standard-gage railroad track runs the length of the turbine room for bringing in material on cars and unloading it by means of a traveling crane of 100-ton capacity serving the turbine room. On a mezzanine floor between the turbine room and the condenser pit is the station switchboard and switching equipment, and lower down in the condenser pit are steam-driven fire pumps and two motor-driven house pumps, all of 1,000 gal. per min. capacity, and having foot valves in both the intake and discharge tunnels carrying the condenser circulating water. The floor of the condenser pit is at the normal river level, giving a minimum lift for all these pumps.

Water from the river is brought into the plant through an intake system made large enough to supply

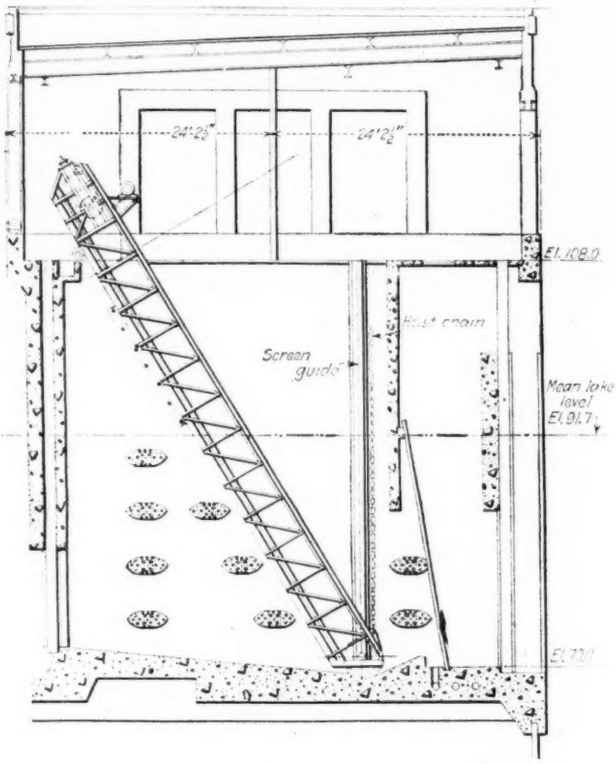

FIG. 10. SECTION THROUGH SCREENHOUSE

the ultimate capacity. It consists of a slip 53 ft. wide, a screenhouse and two concrete tunnels 9 ft. wide, which reduce to 7 ft. as they approach the end units now installed. Lateral branches from wells in the in-

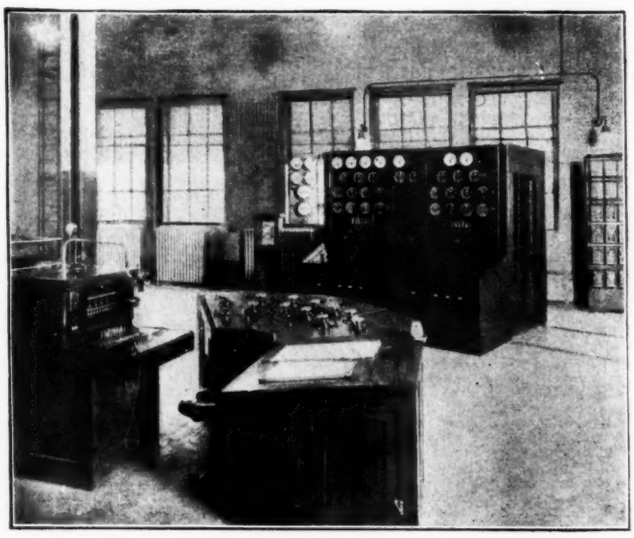

FIG. 11. MAIN SWITCHBOARD IN LOAD DISPATCHER'S OFFICE

take will lead off to the future units as they are installed. Discharge water from the condensers is carried away in a 7-ft. tunnel. Eventually, there will be two of these tunnels, with lateral connections to all units as they are installed, and before passing to the river these tunnels will discharge into the wet pockets for coal storage to keep them from freezing during the colder months.

The screenhouse is of the general design indicated in Fig. 10. Space has been provided for six traveling screens, 50 ft. 3 in. long between centers and 72 in. wide. At present three of these screens are in place, each having a capacity of 75,000 gal. per min. when operating at a speed of 9 ft. per min. and with the water at a level of 20 ft., this being about the normal depth of the water at this point of the river. As indicated in the drawing, provision has been made to pull the screens up to a horizontal position when attention is required. When being elevated, the inner end of the screen travels up on a vertical guide column, and the upper end passes out horizontally through a windowed opening in the screenhouse wall. Stationary racks protect the traveling screens from the coarser particles of débris in the water. The outlet from the screen chamber is at the bottom and into a tunnel entrance flared from 9 ft. to 25 ft. wide at the screenhouse wall.

As previously intimated, the switchhouse is a separate building about 60 ft. distant from the turbine room. On the top floor of this building is the main switchboard, which is of the bench type with indicating meters on the front and the recording ammeters, voltmeters and kilowatt-hour meters, relays, etc., on the rear. As indicated in Fig. 11, the benchboard is of crescent shape so that the operator may have a good view of all instruments. In front of the board is the operator's desk with signal switches for the load sign in the boiler room and a telephone switchboard by which he can call any department of the plant. From the desk the operator flashes the load and also calls the engineers in the turbine room by signal sign and whistle in case of emergency or when it is necessary to put a machine on or take it off the line.

Fig. 12 is a typical section through the switchhouse, which has been carefully laid out, leaving plenty of space for the present equipment and provisions for the future. Fig. 13 is the general wiring diagram of the station.

From the main generating units the leads are conducted to the switchhouse through fiber conduits embedded in concrete. These leads are 1,500,000 circ.mil cables, three to each phase. They attach to flat copper busbars in the switchhouse which pass through compartments to the floor above, where the disconnecting switches and oil circuit breakers of 3,000-ampere capacity, solenoid operated, are located. From the switches these flat copper buses rise to the third floor to the main or synchronizing buses and are then carried downward in compartments through disconnecting and oil switches to the secondary windings of the transformers in which the voltage is stepped up from 6,600 to 23,000 volts. Another set of taps on the transformer make it possible to raise the voltage to 46,000 should it be required for future long-distance transmission. The switching equipment, buses, arresters and the spacing of conductors have all been designed for this higher pressure.

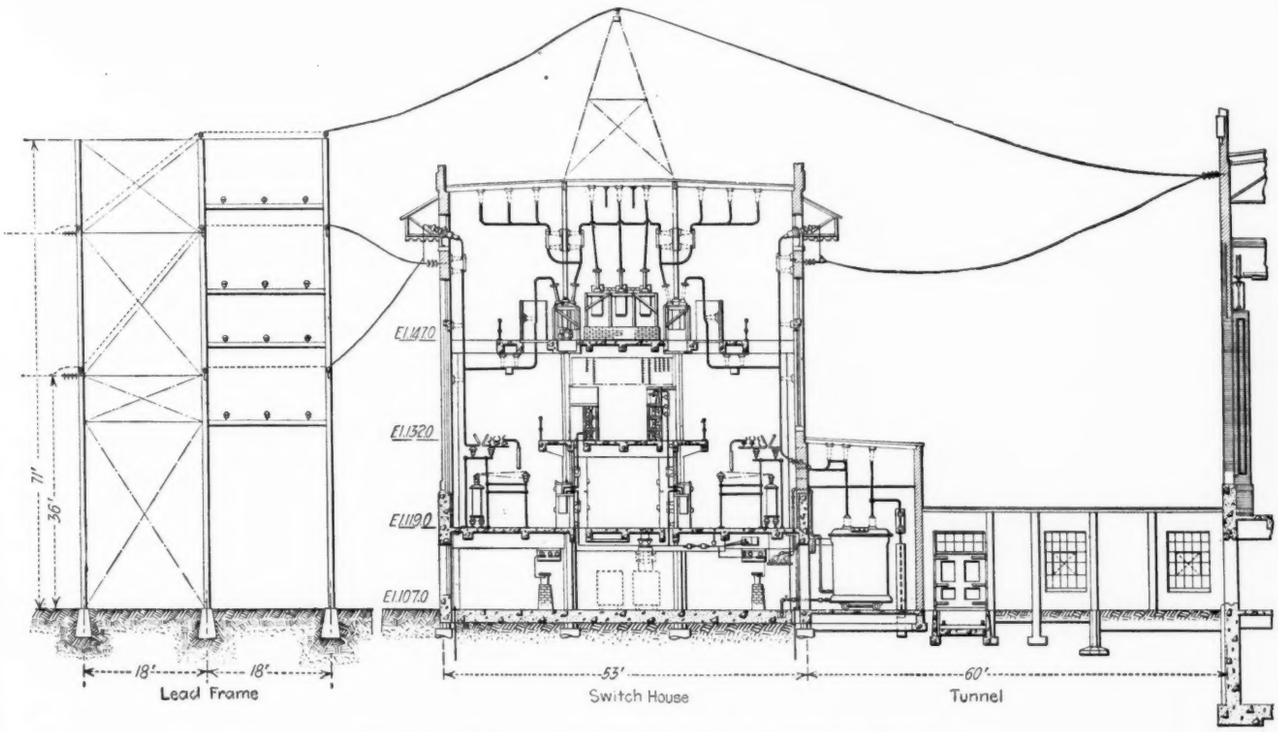

FIG. 12. TYPICAL SECTION THROUGH SWITCHHOUSE

Outside of the basement there are seven transformer compartments of the design indicated in Fig. 12, each having a 6,000-kva. single-phase transformer. The compartments provide for two banks of three transformers with a single transformer in reserve in case of an emergency. All the transformers are mounted on

transfer trucks so that they may be removed quickly and replaced. From the transformers high-tension current passes over ¾-in. copper tubing through oil circuit breakers and two sets of disconnecting switches to a ring bus which circles the high-tension floor and also to a straight main bus. These buses are of 1¼-in. copper tubing, and from them feeder circuits are taken off through disconnecting and oil switches, hour-glass choke coils and then through wall bushings to the lead-out frames for the transmission lines. At present there are four of these feeders of 10,000-kw. capacity crossing the Maumee River to the plant of the Toledo Railways and Light Co., from which the energy is distributed. Two other feeders supply the East Side of the city and various towns along the lines of the Northwestern Ohio Electric Traction Co. The lightning arresters, tapped to the feeders between the wall bushings and the choke coils, are of the aluminum-tray, electrolytic, four-tank type. The high-tension oil circuit breakers have bush-type current transformers with ratios of 600 and 300 to 5 for relay protection.

As indicated in the wiring diagram, the 440-volt station power bus is attached to the 6,600-volt main or synchronizing bus through 500-kva. auxiliary transformers. This auxiliary power bus supplies energy to the various motor loads of the station using alternating

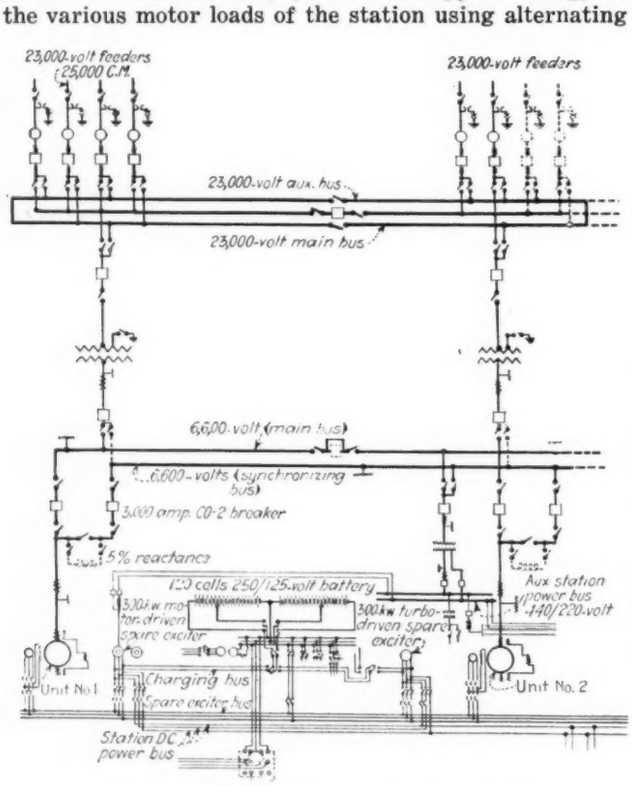

FIG. 13. WIRING DIAGRAM OF STATION

current. There are also direct-current buses supplied from the exciter sets or the storage battery, which is located on the basement floor of the switchhouse and is of 400-ampere-hour capacity. Normally, the battery is used for remote control and emergency lighting, although it may supply for a brief period excitation current or even power to drive the stoker motors.

Credit for the plant design and the supervision of its construction is due G. W. Satthoff, of H. L. Doherty & Co. J. F. O'Connor is general manager of the plant and W. E. Ives is general superintendent.

Maintenance of Motor-Driven Centrifugal Pumping Units

By J. Elmer Housley

The chemical and allied industries furnish many interesting problems in connection with centrifugal pumps, and in a large industry the same problem is often multiplied by duplication of drives. A general method of attacking pump problems is outlined, based on experience with some 400 motor-driven centrifugal pumps, together with a solution of one problem which

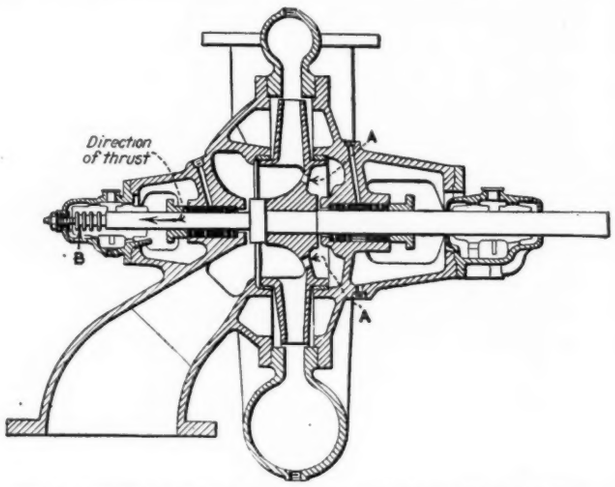

FIG. 1. METHOD OF BALANCING SINGLE-SUCTION PUMPS

more than doubled the life of the bearing on seventy-two 15-hp. motors driving one type of pump.

The arch enemy of pump motors is thrust developed within the centrifugal pump and caused by the pressure on the side of the impeller opposite the suction pipe being greater than the pressure in the suction side of the impeller. In order to neutralize this, holes connecting the two sides are provided in the impeller, as shown at *A*, Fig. 1. In the single-suction pump it is practically impossible to balance the thrust on the pump impeller for all conditions of operations, and the unbalanced thrust must be taken care of by collars on the shaft at *B* or in some cases by the motor bearings where a rigid coupling is employed. In the double-suction type of centrifugal pump, such as Fig. 2, the thrust is theoretically taken care of by equal suction pressures on either side of the impeller, although thrust collars are usually supplied.

In handling fluids containing a fairly large percentage of solids or fluids that deposit scaly matter, the suction parts of the impeller of the double-suction pump sometimes become unevenly restricted, throwing a heavy thrust to one side of the pump. On a large pump a thrust collar is inadequate to care for this powerful force and consequently the impeller rubs against the pump casing, making a friction brake. This will often double the normal load on the motor driving the pump. In cases of overheating of the motor driving this type of pump, a wattmeter test should be made, and if the suction and discharge pressures of the pump are normal and the motor shows an overload, the pump should immediately be dismantled and examined, and any restriction eliminated. When a drive is newly installed, if upon starting, the motor shows distress the pump should be dismantled and the interior inspected for

wrenches, bolts or blocks of wood. It would seem unnecessary to do this, but it is surprising how often such material is found in new pump installations. In the ordinary multi-stage high-speed centrifugal pump the problem of proper balancing of thrust becomes still more important. In these pumps a heavy-duty thrust bearing is usually installed at the factory. However, should the equalizing holes in the impeller become clogged and scaled or should the clearance rings permit an excessive leakage in the suction of the last stage, thereby building up a pressure the drain pipe could not relieve, the thrust force will tend to make a high-speed friction brake of the thrust bearing and, if it does not burn out, will throw a dangerously heavy overload on the motor.

In one case the writer used a medium, single-row ball-thrust bearing between the shaft collar and the coupling side of the bearing shell of various makes of 15-hp. 860-r.p.m. motors, as shown in the drawing, Fig. 3. These motors were driving direct-connected 3-in. single-suction pumps of the open-impeller type with a rigid bolted coupling. This type of pump utilizes the packing gland as the only bearing, and consequently the thrust behind the impeller shroud tends to pull the rotor through the coupling side bearing of the motor, usually wearing out this bearing in nine to twelve months. The use of the ball thrust for two years shows that the ball-thrust bearing itself will not require replacement under two years with continuous 24-hour service. At the same time it extends the life of the sleeve bearings indefinitely.

The cost of changing motors and replacing the destroyed bearings averaged about $15 a year per motor

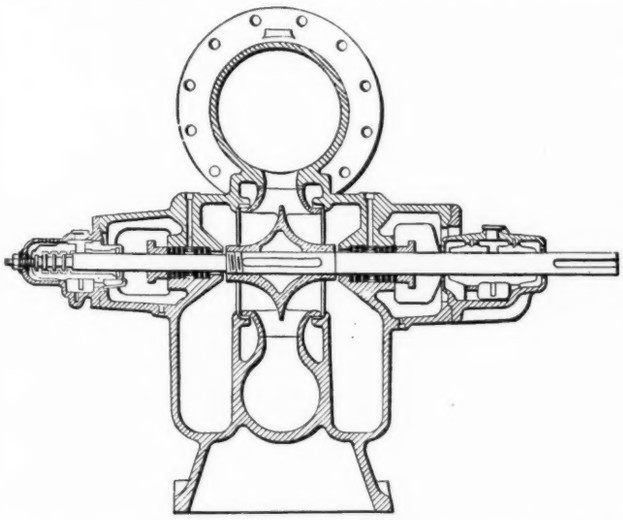

FIG. 2. DOUBLE-SUCTION PUMPS SHOWING ELIMINATION OF THRUST

before the use of the ball thrust. The cost of the ball-thrust bearings installed was $6 each, and if they are replaced as often as every two years, the saving per motor per year will be $8.25, assuming a cost of $7.50 for the labor of changing a motor.

The machine work for fitting the ball thrust consisted of turning the collar on the motor shaft back a distance equal to the thickness of the ball bearing. On a few of the motors it was necessary to file or turn out the inside opening of the motor end bracket in order to receive the ball bearing. The inner race makes a dust seal for the oil well, and the ball race receives its lubrication from the oil thrown from the shaft.

Whenever a new impeller of larger diameter than the original impeller is placed in a pump, a careful check of the motor load should be made as soon as the pump is put in service. The pump load at any given motor speed will usually vary as the cube of the diameter of the impeller, and if this point is not observed a motor burn-

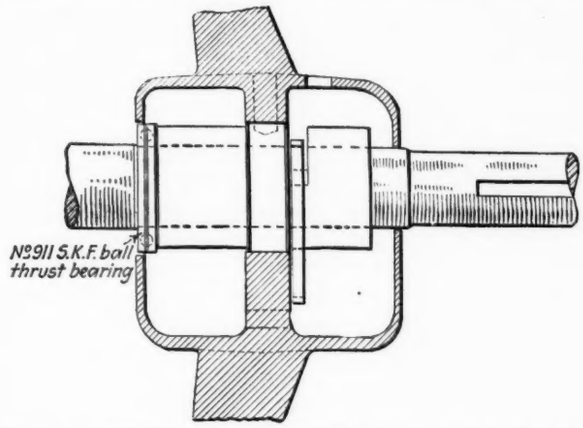

FIG. 3. RELIEVING SIDE THRUST WITH BALL BEARING

out is likely to ensue. The electrical department should always be advised of any changes in characteristics of the pumps prior to the change.

Motors driving centrifugal pumps should be carefully protected from any possible damage due to leaking pump glands or from any liquid dripping from above. When located inside the building, a vertical sheet-iron plate, with a sliding door for oiling the motor, should be placed between the motor and the pump. Another plate should be placed over the top of the motor and inclined so as to drain any liquid falling on this cover. The remaining sides will then be clear except for two cover supports, and ample ventilation is assured. In one factory many pumping units are operating outdoors with only a sheet-iron cover over the motor, inclosed on all sides. In these instances it is essential to have a clear opening around the bottom of the cover and to have a sufficient number of louvres on all sides of the cover to insure ample ventilation; otherwise excessive heating of the motor will occur.

It is likewise important to have the motor and pump mounted on some manner of foundation which will prevent distortion of the cast iron subbase. Many pumping sets have been ruined by failure to observe this precaution.

The problem for the designer or the man analyzing troubles in the combustion space is to convert potential chemical energy into thermal energy most efficiently. There must be just enough space to permit combustion up to the desired stage before the products of this combustion go on into the tube spaces. The fire space must be so shaped as to permit regular movement of fuel and products of combustion with a minimum of eddying or surging back and forth. There must not be too much space lest the products of combustion begin to lose heat before they reach a point where this heat can do useful work. And, too, the walls of this fire space must be so shaped as to reflect the maximum of the radiant heat in the proper direction else it will pass out through the walls instead of being sent on with the rest into the other parts of the boiler.

Problems in Parallel Operation of Compound Generators

By EUSTIS H. THOMPSON

This article relates a series of specific instances of trouble in the operation of compound generators in parallel, giving in each case the symptoms and causes of the trouble, and the remedy that was applied for its correction.

REVERSED Polarity—A small turbo-generator of about 30 kw. had been in operation for a year in the same plant as an engine-driven set of about equal capacity. It had never been possible to parallel the two machines, for the breaker always opened up violently when the main switch was closed. Several engineers had attempted to parallel these machines, and the general conclusion was that it could not be done because the turbo-generator operated at approximately 2,400 r.p.m., while the engine-driven generator operated at about 300 r.p.m. Also the two machines rotated in opposite directions, and this was supposed to have something to do with the trouble.

The real trouble, however, was reversed polarity, as shown by testing the voltage across the jaws of the main switch and then across the blades. The machine was found to have reversed polarity in regard to the busbars, although the station instruments indicated like polarity. It was found that the connections to the voltmeter receptacle on the turbo-generator panel were reversed, as shown in Fig. 1, and after these had been corrected and the machine polarized in the proper direction, multiple operation was absolutely satisfactory.

Overexcitation of Series Field Due to Low Resistance—A generator, when first thrown on the bus was adjusted by means of its shunt-field rheostat to take about three-quarters of its normal load. But it was very unstable and, with the slightest change in the station load, would steal most of the load and appeared about to blow the breaker at any moment. There was no abnormal sparking. This was sized up immediately as a series-field trouble. On checking up operating conditions, the connections for which are shown in Fig. 2, in which machine No. 1 represents the generator under consideration, it was found that there was a drop of potential of about 2 volts from the station equalizer bus to the series-field bus at full station load. The new generator, on the other hand, was found to have a potential drop through the series field of only ¼ volt approximately at full load. The trouble was therefore caused by overexcitation of the series field on account of the excessive equalizing current from the other generators; for in order to give the same series-field drop as machine No. 2, eight times full-load current must flow through the series field of machine No. 1. The trouble was corrected by placing a resistance between the series field and the series-field bus, as shown in dotted lines in Fig. 2, so as to make this drop of potential about 1½ volts greater than before, which produced good operation.

On account of the small number of poles in high-speed turbo-generators, the series field often has much less resistance than a similar size of slow-speed engine-driven generator with many poles. Therefore troubles of this kind should always be allowed for when considering the installation of a turbo-generator with old multipolar machines.

Incorrect Brush Setting—It was found almost impossible to equalize for any length of time two exciters that were connected directly to turbo-alternators. These exciters showed bad commutation, and the load surged from one to the other in an unstable and irregular manner. The trouble was investigated and found to be due to the brushes being shifted too far against rotation. This gave the interpoles a compounding effect that was not taken care of by the equalizer, for the latter could only regulate the current in the series fields and had no control over the interpoles. The trouble was corrected by shifting the brushes of each machine to their proper running point.

Excessive Resistance in Equalizer—Two generators, when thrown in multiple, showed considerable surging in an unstable and uneven manner, with no abnormal sparking. The brush position was correct, but it was found that the distance from the switchboard to the machine was so great that the effect of the equalizer was greatly reduced on account of the high resistance of the leads. This was remedied by placing a short equalizer from one machine to the other, the resistance of the new connection being about one-tenth that of the former. The machines then operated perfectly in parallel.

Friction in Governor Action—Two turbo-generators of the same capacity had been operating for a year or more, but would never run satisfactorily in multiple. Sometimes the circuit breakers would fly open as soon as they were paralleled, sometimes only after a short time interval. There was a great amount of surging of the current. This surge, however, seemed to have a regular and well-defined period, and there was no abnormal sparking. This indicated governor trouble. It was found that the voltage varied considerably when either machine was running alone, further confirming the foregoing. On examination it was found that the dashpots of the turbine governors were sticking on account of the plungers fitting too tightly. The fit was eased off with a file and lighter oil used, which solved the trouble.

Water in Steam Line—Two turbo-generators in a small plant were subject to sudden inability to carry the load. This trouble did not occur at any regular interval nor was it confined especially to either machine. As the generators at other times gave normal service, the trouble was looked for in the turbine. When the trouble occurred, the speed would drop suddenly, although the valve gear opened up the valves correctly and the steam pressure remained normal. There was no other evidence to indicate any other trouble. After considerable investigation it was found that this slow-

ing down was caused by water collecting in a pocket of the steam pipe and then coming over in small quantities. This was found to be true when water was discovered in the turbine casing on opening a drain cock. On large machines or under almost any other condition there would have been some vibration or other indication of water trouble.

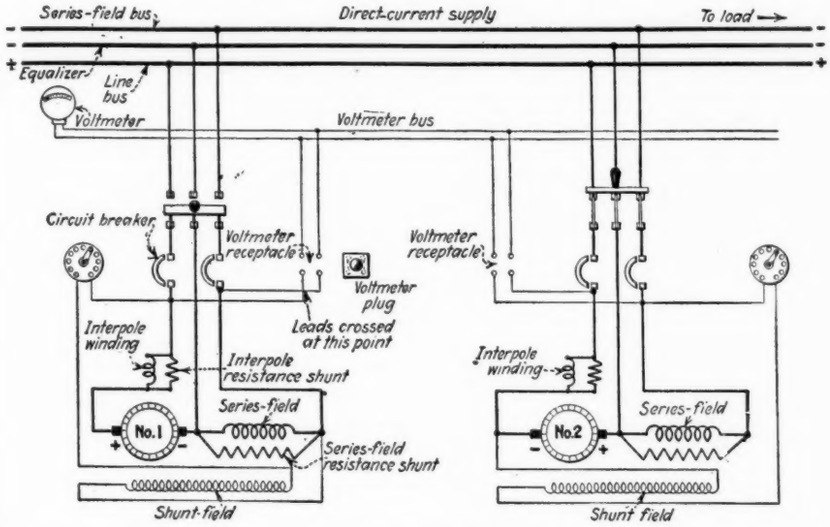

FIG. 1. PARALLEL OPERATION PREVENTED BY REVERSED POLARITY

Note reversed connections to voltmeter receptacle, giving positive indications on the instrument in spite of the reversed polarity of the machine, thus hiding the trouble.

Loose Joint in Series-Field Bus—A generator that had given satisfactory multiple operation for a long time was started up after an extended period of inactivity, and was found to have spells of intense overcompounding, during which it would steal all the load and open all the breakers in the station. The machine was carefully inspected without finding any cause for such trouble. It was decided to run the machine by itself and see if any abnormal symptoms would eventually develop. It was found that one of the blades of an open switch near by became heated. The machine had previously been checked over for loose series-field connections, but this heating was the means of discovering in the series-field bus a bad joint that had previously been overlooked, and was close enough to the open switch to warm it by heat conduction. The joint was taken to pieces, thoroughly cleaned and well bolted, and the trouble disappeared.

The explanation of this trouble is as follows: Let *A*, Fig. 2, be the location of the poor joint. The connections are shown diagrammatically in Fig. 4, where the poor joint *A* has been indicated as a resistance in series with the series-field bus. Machine No. 2 in both figures is the one that gave trouble.

Under normal operation the electrical contact in the bad joint was relatively good and resistance *A*, Fig. 4, correspondingly low. Now from time to time this resistance would suddenly increase considerably, due perhaps to a sudden shifting in the joint caused by the expansion or contraction of the bus, or to vibration, or any other cause tending to produce movement in the joint. This would suddenly introduce a relatively high resistance in series with machine No. 1, automatically throwing the larger portion of the outside load on machine No. 2. Furthermore, the resistance *A* of the weak joint might become several times as great as that of the series field of machine No. 1. The two series fields being connected in parallel through the equalizer, this would cause the series field of No. 2 to carry nearly all the current from the two machines, causing the intense overcompounding observed. The tendency of machine No. 2 to steal the load, instead of being checked by the equalizer, was therefore very much increased by it.

Different Shape of Voltage Curves—A small generator, when put in service for the first time in multiple on the station busbars, was found to take considerably more than its share of he station load at light loads, while at overloads it undercompounded so badly that the station load was thrown on the other machines and there was danger of blowing the breakers on these machines and shutting down the plant. On looking into the matter, it was found that this machine had the correct compound from no load to full load, but that its voltage dropped rapidly under overloads. The trouble was traced to the shape of the voltage curves of the different machines. Whereas the old generators presented a relatively flat voltage curve, as shown in Fig. 3 under the designation of "Station Voltage," the new generator was designed with considerably more resistance in its windings and had a much more pronounced "peak." This is clearly shown in Fig. 3. The result

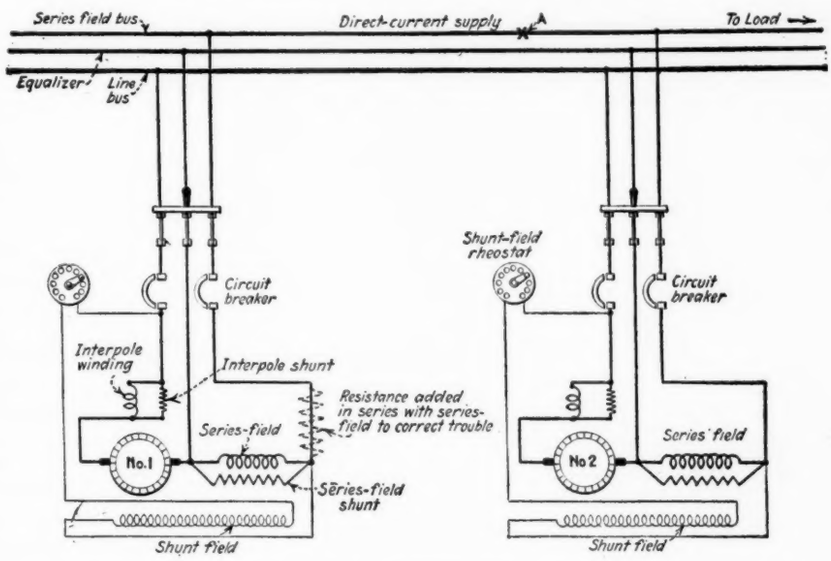

FIG. 2. LOW RESISTANCE OF SERIES FIELD CAUSES MACHINE TO STEAL THE LOAD

Machine No. 1 had a full-load voltage drop of only ¼ volt through its series field, as compared to 2 volts drop through the series field of No. 2. The two series fields being in parallel through the equalizer, that of No. 1 drew eight times its full-load current. The trouble was corrected by adding a resistance in series with the series field of No. 1, so as to reduce the equalizing current supplied to this machine.

was that at light loads the new machine, having a higher voltage than the other machines, took most of the station load, whereas at heavy loads its voltage dropped so low that it refused to carry its share. There were several ways of correcting these conditions. The easiest way and the one used was to increase the compounding of the new machine by increasing the length of the series-field shunt, so that its voltage was higher than the station load at full load, and about equal to the station voltage at 25 or 30 per cent overload. This increased the excess load on the new machine at light loads, but under the circumstances this was not objectionable, and it caused the new machine to divide the overloads satisfactorily with the other machines.

There are other methods of correcting such a curve. One way would be to change the adjustments of the governor, if possible, so that a given increase in valve opening would demand a greater drop in speed at light loads than at overloads. Another method would be to insert resistance in the armature leads of the station generators so as to give the station load a more peaked characteristic and a greater drop at overloads, so as to be more like the new machine. Both of these methods are objectionable, as the former would require a special governor setting that might be disturbed in making repairs and the latter would mean valuable power going to waste in the resistance.

A peaked voltage curve is sometimes caused by the machine being too low on the saturation or, in other words, containing too much iron. Such a condition should be referred to the manufacturer. In this case there is usually a certain amount of surging of the load,

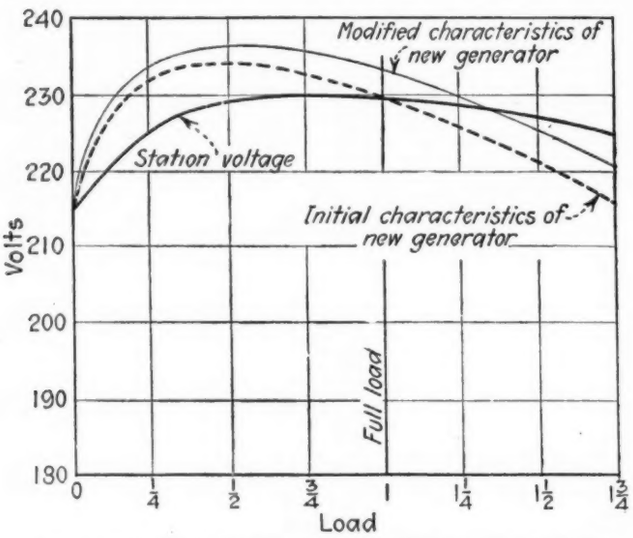

FIG. 3. PEAKED VOLTAGE CHARACTERISTIC CAUSES UNEQUAL LOAD DISTRIBUTION AT DIFFERENT LOADS

The machine takes more than its share under light loads and less than its share of overloads.

particularly at light loads. A poor adjustment of the governor regulation when the machine was first adjusted for correct compounding might also account for such trouble.

Pipe Scale in Steam Line—A turbine set that had been operating well suddenly began to lose its ability to compound and soon became unable to carry its share of the station overloads. The operation of the generator was normal, while the turbine valve gear functioned properly and pressure in the steam main remained constant. But the speed would drop excessively on heavy loads. From the fact that this was a constant trouble and gradually became worse, it was inferred that the cause was a stoppage in the steam system. This was easily located in the steam strainer, which had filled up with pipe scale.

Weakening of Governor Spring—A generator that had been in operation for a considerable length of time gradually lost its overcompound, so that its voltage

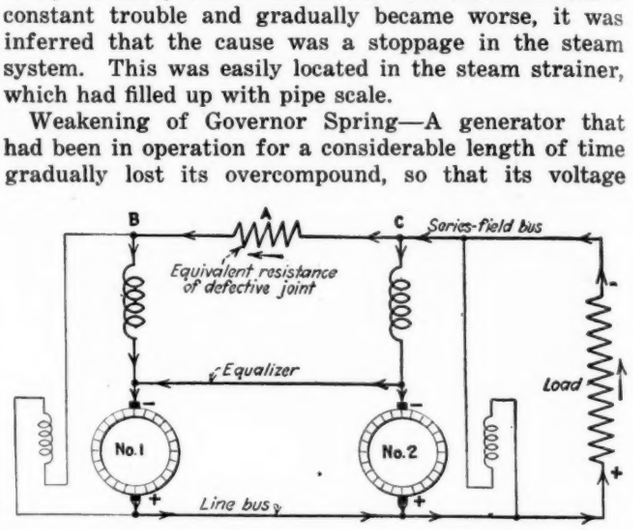

FIG. 4. SCHEMATIC DIAGRAM OF CONNECTIONS IN FIG. 2 SHOWING DEFECTIVE JOINT AT *A* IN SERIES-FIELD BUS AS A RESISTANCE IN SERIES WITH MACHINE NO. 1

fell somewhat on heavy loads. This condition occurred very gradually so that the actual change from day to day was not perceptible, but eventually the drop of voltage became serious. The generator was found to operate normally from outward appearances, but on checking the speed it was found that the speed regulation of the set was two or three times the original range required. It then appeared that the governor spring had changed somewhat in elasticity as well as in actual adjustment, owing to the wear of moving parts. This resulted in a lower full-load speed and much broader regulation than normal. After proper governor adjustments operation was normal once more.

Control of Boiler Operation

BY W. L. LUNDY

There are two methods that can be used to ascertain the economical status of a boiler plant—the mechanical method, based on the heat utilized, and the chemical and physical method, based on the heat wasted. To obtain the efficiency of a boiler plant by either of these methods, the following information must be obtained:

For the mechanical method: Weight of steam produced; weight of coal consumed; quality of the steam; temperature of the feed water; heat value of the coal used and the steam pressure.

For the chemical and physical method: Temperature of the flue gases; composition of the flue gases; ash and hydrogen in the coal and the combustible in the ash.

Plants that use the mechanical method alone for the control of boiler-plant operation, usually obtain only the weight of coal, weight of water, average steam pressure, average feed water temperature and the average heat value of the coal, over a period of a day, a week or a month. The data obtained enable one to calculate roughly what percentage of the heat in the coal fire is utilized in making steam. This method suffers, as a means of boiler-plant control, not only from the lateness of getting the desired information, but also in accuracy and reliability, due to the following

errors, and shortcomings. The water shown by the meter is not all evaporated. Some may be lost through a leaky blowoff, moisture may be carried over by the steam and a considerable amount of water is wasted by blowing down the boilers. Furthermore, the coal weigher cannot discriminate between coal and ash and moisture. The most serious shortcoming of the mechanical method is that it gives no clue as to why the plant is operating more or less wastefully.

The chemical and physical method of control possesses several advantages over the mechanical method, if accurate information is desired. It can be more easily and cheaply installed; the records show up the operation of the boilers continuously; it shows up combustion and absorption efficiency factors separately, so that proper steps to improve the efficiency of the plant can be promptly and intelligently taken; the value of its records is not affected by a variation in the ash and moisture content of the coal burned; the record is not affected by the waste of feed water or the variation of its temperature.

To obtain maximum boiler efficiency every boiler must be treated as an individual and the boiler and furnace considered separately. In the furnace a chemical reaction takes place between the coal and air, and it should be controlled by chemical means. In the boiler absorption takes place and should be controlled by physical means.

The three instruments for obtaining data on the furnace and boiler are the CO_2 recorder, the flue-gas pyrometer and the draft gage. With these instruments on each boiler the firemen have before them the information necessary for intelligent and effective control of their fires. Without them they have no means of knowing how efficiently steam is being produced. The steam gage will tell them whether or not the boilers are making the required amount of steam, but they may make large volumes of steam and waste fuel in doing it, because it is possible to have a combination of a high rate of combustion, a high percentage of excess air and a high rate of steam production. The steam gage tells them when to increase or decrease the rate of combustion. The draft gage tells them whether the air supply is right for the required rate of combustion. The CO_2 indicator tells them whether the thickness of the fire is right, and the furnace draft indicates the condition of the fire.

For any given set of conditions, kind of fuel, construction of furnace and method of stoking, a definite volume of air will consume a definite maximum weight of fuel. The draft gage is the instrument to use for regulating the rate of combustion, and the CO_2 recorder shows whether the fuel supply should be increased or decreased to produce maximum combustion efficiency. The proper drafts to be used and the maximum CO_2 percentages to be obtained to secure maximum combustion efficiency under the various operating conditions, should be ascertained by trial with draft gages and Orsat apparatus, and then the firemen should be instructed how to apply the information given by these recording instruments.

The records of CO_2 temperature of flue gases and drafts give the engineer in charge, the following information:

Whether normal combustion efficiency has been maintained, and if not when it became abnormal, and how long it remained so. The continuous record of CO_2 shows how long doors were left open, when the fires were cleared and how long it took to clean them. In underfeed stoker-fired boilers of the hand-dumping or power-dumping type it gives, in conjunction with the furnace draft and wind-box pressure, the information of whether proper care has been exercised to burn the combustible, which reaches the dump grate before the ashes are dumped.

The temperature record shows whether the absorption efficiency has continued normal; if not, the variation may be due to necessary variations in the rate of driving and if so, this is revealed by the draft-gage records. An increase in temperature may be due to a breaking down of the baffling, which is revealed by the boiler draft. The mucking up of the heating surface is indicated by a gradual increase in the temperature of the escaping gases. In plants having mechanical soot blowers installed, the recording pyrometer shows whether these have been used properly and regularly. The temperature immediately after cleaning the heating surface with the boiler at full load should be taken as standard, and if the flue-gas temperature remains 150 deg. higher than the standard, the boiler needs cleaning or the baffles need attention.

Caution should be taken in measuring the temperature of gases surrounded by bodies at different temperatures, on account of radiation effects. The thermocouple of the pyrometer should never be placed between the tubes of a boiler as there may be as much as 20 per cent error in the readings. The point of the thermocouple should be in the direct path of the gases just after they leave the heating surfaces, and at the same place at which the flue-gas sample is taken.

In the average boiler plant the increase in combined efficiency that may be obtained from the installation of necessary instruments, will pay large dividends on the money invested.

If both the mechanical method and the chemical and physical method of boiler control are used in a boiler plant, results will be obtained very nearly equal to those obtainable under test conditions, provided, however, that the firemen are properly instructed in the use of instruments and the records are carefully and regularly scrutinized and correlated and the information they give promptly and intelligently applied. With both of these methods installed in a boiler plant, a continuous heat balance may be calculated, which is the only means of maintaining maximum boiler and furnace efficiency. Any attempt to operate a boiler plant efficiently without the information necessary for a heat balance is futile

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The Big Creek Plant No. 8, of the Southern California Edison Co., will probably be the first plant in the world to use a transmission electrical pressure as high as 220,000 volts. The Edison company, in conjunction with Professor Ryan, of Leland Stanford University, has been carrying on extensive experiments with the purpose of converting the present Big Creek line from an operating electrical pressure of 150,000 volts to 220,000 volts. It is expected that operation at the higher voltage will be accomplished in 1922. In the meantime energy from Big Creek No. 8 Plant will be transmitted at 150,000 volts. Transformer equipment for the power house was purchased so that it would be possible to operate temporarily at 150,000 volts, and later on, with the conversion of the Big Creek Line to the higher electrical pressure, to deliver the output from this plant at 220,000 volts.

Power-Plant Accounts—II. Use of Journal and Ledger

By WILFRED A. MILLER

ASSUMING that we have decided to find out just how much it is costing us to generate our power, we find that the first step is to install some simple set of records by means of which we can keep track of all the items, large and small, that form a part of the cost. The initial record, or *journal*, of such items, need be only an ordinary blankbook in which is jotted down from day to day each item as it comes to our attention. For this purpose it will be convenient to rule a few pages with columns as shown in Fig. 1.[1] The entries may be made in pencil, which will allow changes to be made readily. We may expect to make a good many of them until we become accustomed to doing "bookkeeping," because that, after all, is what the keeping of any set of records amounts to. Later the earlier efforts can be transcribed to a fresh book where the entries can be neatly made in ink as a permanent record.

The memoranda which we shall be called upon to make in the journal may be classed under the following headings:

Classes of Items Entering into Cost of Power: (1) Labor (wages); (2) fuel: (3) water; (4) lubricants; (5) ash removal; (6) repairs; (7) scale removal; (8) miscellaneous supplies; (9) investment.

Some of these may require an entry every day, as coal for example, some once a week or once a month, as for instance wages and water, and some items, such as lubricants or repairs, will entail only an occasional entry. The important thing is to jot down an item as soon as we know of it; otherwise we might forget to make an entry for it and our record would be incomplete. The first thing to do when about to make an entry is to decide in what class it belongs. We write this in the column headed "Class," filling in the date at the same time. Then in the column headed "Description" we make a complete notation as to what the entry is for, and finally enter the amount in the right-hand column, if we know what it is. If this is not known at the time, the space is left blank, to be filled in after we have found out how much it is.

It is well to keep the pages for one month separate from those of other months. That is, when we come to the end of a month we start the new month on a fresh page, even if the last entries for the old month come near the top of the preceding page. In that way the events of each month are kept entirely apart from those of any other. In getting results and making comparisons, it is the generally accepted practice to make the month the standard period rather than the week or the day, so that we may adopt this plan in keeping our records. This means that there is no need to worry if it is not possible to assign to each day or each week the exact amount of the expense incurred, so long as we know that the total for the month is correct. For example, let us suppose that we are having some repair made by a firm of boilermakers and that it takes them several days to make it. Do we have to try to find out how much of their bill should be charged to each day that they were working on the job? The answer is, of course, No. We do not care how much of the charge belongs to the individual days; all we are interested in is how much all the repairs for the month cost us, which means that we need make only one single entry for each bill. The best time to make the entry is on the day when the work is finished; then we will not forget to include it in the month's expenses, even if the bill doesn't come in for some days after the last of the month, as will sometimes be the case.

This is the second of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough yet extremely simple manner. They were prepared primarily for the guidance of the operating engineer who wants to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. This installment starts by reviewing part of what has gone before and then takes up the following: Use of ledger for sorting out journal entries by classes; distinction between left and right half of ledger sheet; getting monthly totals and grand totals.

Having adopted the month as our standard recording or accounting period, we must make provision for separating out at the end of each month all the items that have been jotted down in the journal during the month. Before doing so, however, it is important to make sure that no item has been omitted, and that we have obtained the correct amounts for those items for which the amounts were not known when the entries were made.

Next comes the work of separating out the items. In looking over our journal, we find that all kinds of expenses are mixed together, just as they occurred from day to day, in no particular order. The question arises, What information are we interested in getting from these entries? The obvious answer is, of course, We wish to know the cost of producing power for the month. That is true; but it is not all. We also want to know of what that cost is composed. If only the total cost for the month were desired, it would merely be necessary to add together all the entries in the "amount" columns of the journal pages for the month to get the required figure. But it is important to know much more. We want to know how much of the total cost is for labor, how much is for fuel, how much for water, how much for lubricants, and so on. A simple way to do this would be to rule off a number of columns on a sheet of paper and head each one of

[1] It is not advised that the reader go to any great trouble or expense in preparing a book ruled as shown in Fig. 1 for the reason that a more convenient form of journal ruling is described in the next article. The form shown in Fig. 1 is explained first because it appears simpler. After the reader has learned the advantages of the improved form, he will doubtless wish to use it for his permanent journal.

them with one of the classes into which we have divided our costs, somewhat as in Fig. 2. Then we could run over our journal entries and transfer each item to the proper column on the sheet and then add up the columns. This would give the charge for each class of expense for the month. Then we would file away these sheets as part of our record and use them to make a comparison of one month with another.

While such a method of "summarizing" the results could be used, it would mean keeping a lot of loose sheets as part of the final record, which experience has proved to be very objectionable. Moreover, if someone were to ask what it has cost for repairs since the books were started, we would have to dig out all the monthly sheets and do some lightning calculating. The objections to such a system can be overcome by providing another book in addition to the journal and setting aside in it a separate page for each class of expense. Then, instead of copying the entries from the journal onto the loose sheets, we would transfer them to the proper pages in this new book. By adding up each page we would get the total for each class of expense, just as we did by adding the columns on the loose sheets. Moreover, we could add each month onto the total for the preceding months and so incorporate in the record the total, to date, of each class of expense.

Let us start such a book and call it our "ledger." For the purpose a blank book may be used like the one used for the journal, but instead of ruling columns as in the journal it will be found more convenient to

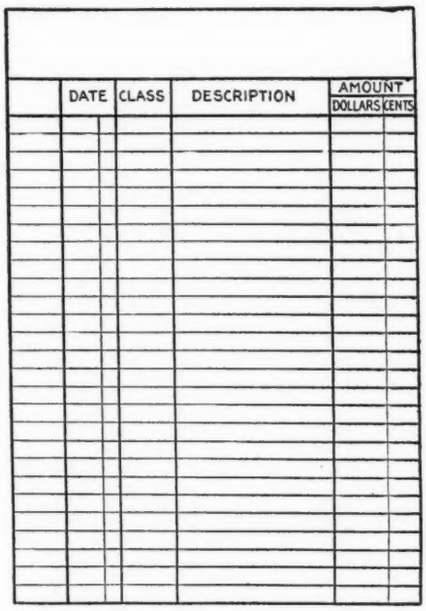


FIG. 1. SIMPLEST FORM OF "JOURNAL" SHEET

rule them as shown in Fig. 3. It will only be necessary to rule enough pages to provide for our immediate needs and pencil entries will be perfectly satisfactory at the start. When we have acquired a little experience in handling them, we can look forward to starting out fresh in a new book and copying the work in ink, just as we intend to do with the journal. Almost any stationary store can furnish books already ruled as illustrated in Fig. 3. The same is true of books with the journal ruling, so that it will not be necessary to spend any time on that kind of work after starting the more permanent records. In starting to rule the temporary ledger, we know for one thing that there must be a page for each class of cost. According to the classification we are using, there are nine of these. Consequently, it would seem reasonable to use the first nine pages in the book. However, a moment's thought will prove that this would not be the most practicable thing to do because some classes will have many more entries in a month than others. Thus, for fuel we can expect to have an entry every day, whereas for scale removal there might be only one for the month or perhaps none

LABOR	FUEL	WATER	LUBRI-CANT	ASH REMOVAL	REPAIRS	SCALE REMOVAL	MISC. SUPPLIES	INVEST-MENT

FIG. 2. SHEET FOR RECORDING MONTHLY TOTALS OF VARIOUS KINDS OF EXPENSE

at all. Consequently, the ledger page for fuel would fill up very rapidly, while that for scale removal would remain almost blank. Therefore it is well to decide which classes will require many entries and which will need few. Then a number of pages can be set aside for the voluminous accounts and only a few or, in many cases, only one page for the others. It will be found to be a great convenience to have all the pages of one account follow directly after one another, so enough space should be allowed for each class of items to avoid the necessity of skipping to another part of the book.

The various classes of costs are ordinarily called "accounts." To say that there is in the ledger an "account" for labor, an "account" for fuel, etc., has a more definite meaning than to say that we have a "class" for labor or a "class" for fuel. We will therefore continue to use this word "account."

The question as to how many pages shall be set aside for each account will have to be determined by our judgment. It will vary in each plant according to the conditions of operation and the length of time we expect to use the books. It is not likely that we shall guess it just right the first time, and here will be an advantage in having kept the record in pencil, for we can readily make any changes that prove to be desirable as we go along. Then, when we come to open a better set of books, we shall have our experience to guide us in laying them out. Let the reader decide for himself what number of pages to allow for each account, and having done so, let him enter the title of the account at the top of the first page so set aside. There will then be nine accounts scattered through the ledger. It will be found a great convenience to number the pages, if they are not already numbered, and to leave the first page in the book as a memorandum of the pages on which to find the various accounts. The pages of the journal may very well be numbered also.

We are now ready to transcribe the entries from the journal to the ledger. We turn to the first entry in the

journal. Assume that it is for "Fuel." We look up the ledger-page number for "Fuel" and turn to it. Then we copy onto the first blank line on the ledger page the date and the amount as they appear in the journal. In the "Explanation" column we also make a brief note of the description which appears in the journal. This note might be "10 tons coal," or it might be "cylinder oil." In addition to making this transcription, we also enter in the column headed "Ref." the number of the journal page from which the information was taken. Also, in the journal, in the blank column to the left of the date we make a note of the ledger page to which we have transcribed the entry. We then have a cross-reference that will aid us if we ever want to trace out any transcription. Thus, in going over the ledger we can tell at once where any transcription came from, or in going over the journal we see just where each entry was transcribed to. Noting the ledger page number in the journal has an added advantage in that it is a sign that the transcription has been made. Should an entry be found without a ledger page number opposite it, it would be an indication that we had forgotten to transfer that item and we would investigate and correct the omission. Transcriptions from the journal to the ledger are often called "postings," and since this is a shorter word than the other we may as well use it.

It is unnecessary to wait until the end of a month to begin making the postings; they may be made every day, or every few days; in fact, at any time when we

LEFT HAND SIDE					RIGHT HAND SIDE				
DATE	EXPLANATION	REF.	AMOUNT $	AMOUNT ¢	DATE	EXPLANATION	REF.	AMOUNT $	AMOUNT ¢

FIG. 3. "LEDGER" SHEET

have time to make them. Nor must we finish posting all the items once we have started; we can stop at any item and resume at some other time. Here is where the system of recording the ledger page number adjacent to the journal entry is convenient, because when the posting is resumed we can tell just where we left off by looking for the last entry which has such a page number opposite it. That one is the one posted last, and we therefore know that the one following it is where we must resume. It cannot be too strongly emphasized that the time to enter the reference number in the journal is *after* the posting has actually been completely made in the ledger. If the reference number were entered first and then the posting were suddenly interrupted, this item might never get posted at all.

Nothing has so far been said about the construction of the ledger sheet shown in Fig. 3, and it is therefore time that some explanation of it be given. Its outstanding peculiarity is that it is divided into halves vertically—a left-hand side and a right-hand side. Of

ACCOUNT	LEFT	RIGHT

FIG. 4. SHEET FOR ADDING THE LEDGER SUBTOTALS

these, the left one is practically the only one that we will use. All postings, unless it is distinctly stated to the contrary, are understood to be made to the left-hand side. To explain the use of the right-hand side, reference must be made to a type of journal entry that occurs only occasionally. It is the type of entry that records the receipt of money instead of its payment. Such a case would, for example, result from the sale of ashes. Suppose the plant is situated in a locality where we can sell the ashes instead of paying for their removal. In that event we would have to identify the journal entry which records the transaction in such a way that it would not be included among the expenses for the month, since it is really income. To do this we may draw a line completely around the amount, or, preferably, enter the amount in red. When we do the posting, our eye will be caught by this identification, and we will know that the entry must be posted differently from the others. The thing to do is to post it in the right-hand column. Thus, we may say that the left-hand column of each account is reserved for amounts that we must pay out, whereas the right-hand one is used for amounts that we receive.

It may not be clear at present why we should have two-column pages for all of the accounts, since it seems as if it would be impossible to receive any payments in the case of most of them, but even granting that this is so, it would surely be undesirable to have some accounts of one form and some of another. If they are all alike, there will be no confusion. As a matter of fact we may find some use for two columns even where it would not be suspected. For instance, it doesn't seem that repairs could ever pay us anything; yet look at the case of an overcharge being made to us. The overcharge may not be discovered until after we have made the journal entry and posted it to the ledger. Shall we go back and change all our bookkeeping when it is discovered? That would be very unsatisfactory. When the person who made the overcharge lets us know how much he is allowing us, we can make a red pencil entry of the amount in our journal, since he is really paying back to us a part of what he first charged. Then all we have to do is to post this amount to the right-hand column of the Repairs account. It is evident that by subtracting the amount posted in the right-hand col-

umn from that previously posted to the left-hand one, we shall have the amount actually paid for the repairs. To make provision for all possible contingencies of this kind, we will use the left and right type of ledger page for all our accounts.

When we think that all the journal entries for a month have been posted to the ledger, we should go over the journal once more to make sure that such is the case. This is done by running down the first column—the one that contains the ledger-page numbers—and making sure that there is a number opposite each entry. If there is any without such a number, we look it up and make the posting if it has been omitted. Having assured ourselves that all journal entries have been posted, the next step is to add up each of the ledger pages, both left-hand columns and right-hand columns, if there are any postings in the latter. The addition in each case can be entered in small figures directly below the last posting. This gives the total of each class of expense during the month, and it only remains to find the grand total. To do this take a piece of paper and rule two columns on the right of it as shown in Fig. 4, heading one "Left" and the other "Right." Then in the wide column headed "Account" enter the names of the different accounts and opposite each name the total for the months as figured on the ledger page. The totals of the left-hand columns are placed in the column headed "Left," those of the right-hand columns in that headed "Right." Having entered all the amounts, we get the total of the "Lefts" and the total of the "Rights." By subtracting the "Right" total from the "Left" total, we will, finally, get the total cost for the month.

Steam-Engine Pistons and Packing Rings

By R. A. Cultra

Steam-engine pistons are made in two principal types, solid and built-up pistons. A solid piston has grooves cut in its circumference to hold the snap packing rings. Fig. 1 shows a solid piston that is secured to the piston

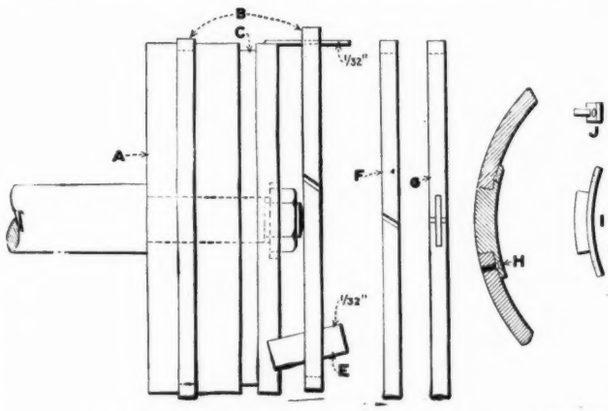


FIG. 1. SOLID PISTON SNAP RINGS

FIG. 2. PACKING RINGS AND JOINTS

rod by a locknut that holds the piston *A* against a shoulder on the rod. *B* represents the packing rings, one of which is in place, and *C* is the slot in which the other ring is to be placed. The rings are of cast iron and are turned a little larger than the cylinder bore so as to expand to the bore of the cylinder after cutting. The brittleness of the ring metal makes it a delicate job to spring them on over the piston without the risk of breaking them. A ring is shown in the position of being snapped over the end of the piston. *E* is a piece of $\frac{3}{32}$-in. steel plate, several of which are slipped under the ring with the end on the edge of the piston. By

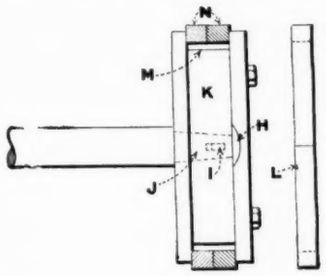


FIG. 3. SMALL BUILT-UP PISTON SHOWING METHODS OF FASTENING PISTON TO ROD

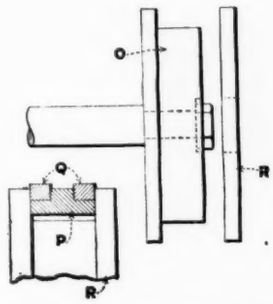


FIG. 4. BUILT-UP PISTON, FOLLOWER PLATE AND BULL RING, PACKING RINGS IN PLACE

sliding them around at equal distance on the piston, the ring will be expanded until it will slip over the piston without risk of breaking. It is then moved along until it snaps into its slot; the piston is then ready to place in the cylinder.

In Fig. 2 are shown several types of ring joints. *F* is a snap ring diagonally cut, the two ends being intended to fit closely together when in the cylinder so that leakage past the piston through the slot is at a minimum. The wider the slot the greater the amount of leakage and therefore many large pistons are fitted with rings in which a slot is cut in each end of the packing ring and in which is fitted a tongue piece (as shown in the ring) *G* is attached to the back of the packing ring by a screw *H*. The shape of the tongue is shown at *I* and an end view *J*. The tongue piece is attached to one end of the ring and is free to move in the slot of the other end of the ring.

Piston rods are made with a shoulder against which the piston bears, or the end of the rod may be turned tapered to fit in a tapered hole in the piston. The piston may be held on with a nut and locknut or the rod may be riveted over, as at *H*, Fig. 3, or it may be keyed on, as at *I*. *J* shows the tapered end passing through a built-up piston of small size. The piston consists of a spider *K* which is made with a flange. A wide split expansion ring is placed over the spider as at *M*, and this ring forces the packing rings *N L* out against the cylinder walls, keeping the piston steamtight.

The built-up piston of large size consists of a spider *O*, Fig. 4. The bull ring *P*, the purpose of which is to carry the packing rings *Q*, is fitted loosely on the spider *O* and held there by the follower plate *R*. A built-up piston with the follower plate removed is shown in Fig. 5. The rim of the spider *M* is tapped for the follow bolts. *T* is the packing ring and a bull ring surrounds the spider and carries the packing rings. It is prevented from turning by dowel pins in the spider, which fit into the slots in the bull ring as at *V*.

In horizontal engines the weight of the piston comes on the bottom of the cylinder, at which point the packing rings wear most. This allows the piston rod to rub on the bottom of the stuffing box, causing a worn piston rod and leaky packing. It is necessary therefore to

provide means for centering the pistons in the cylinders. This is accomplished by adjusting bolts *W*, which are set in the rim of the spider, as shown, with locknuts to hold the piston central in the cylinder, thus bringing the rod central in the stuffing box. These bolts *W* bear against the bull ring.

The follower bolts should be screwed up tight, but not so tight as to stretch or break them, as the head might drop into the valve chest and be caught in the valve and port, breaking the exhaust valve. Although many engineers use a single-ended box wrench to tighten follower bolts, they also go over them in turn and drive on the wrench handle to make sure the bolts will not come loose. Considering this, it is surprising that more do not break.

If the piston is removed from the cylinder, the packing rings will expand larger than the cylinder bore and must be contracted before the piston can be replaced. When putting the piston in the cylinder the end of the rod must be prevented from striking and marking the cylinder walls.

In Fig. 6 is shown the cylinder bore and counterbore and the piston about to enter the bore of the cylinder, but the expanded packing rings will catch on the shoulder. To prevent this use wooden wedges with the large ends against the shoulder of the counterbore, all the way around the piston, to guide and compress the piston rings into the cylinder.

Sometimes a piece of tin strip is put around the rings and tied tight with a cord until they enter the cylinder

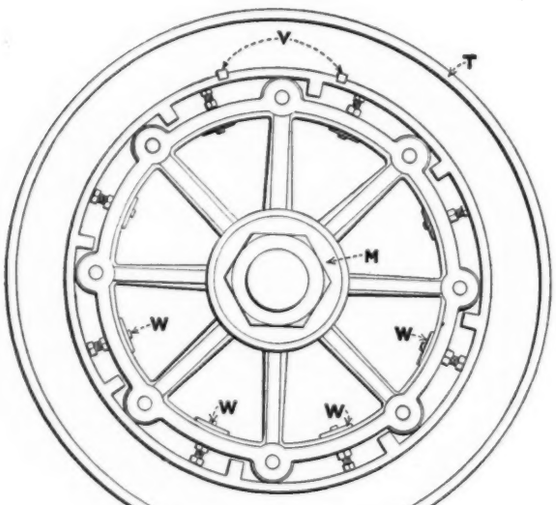


FIG. 5. BUILT-UP PISTON WITH FOLLOWER PLATE REMOVED

where the tin strikes the edge and is forced back over and off the piston as the piston and rings pass in.

Built up pistons are used mostly on horizontal engines on account of the centering of the piston rod. Solid pistons are used largely on vertical or marine engines, as the piston rod acts as a guide, carries their weight; they do not bear heavily on any part of the cylinder wall and do not require centering. In some marine engines a steel piston is used, of a built-up type, having a junk ring bolted to the piston in place of the follower plate to hold the packing rings in place against the piston flange. The packing rings are held against the wall of the cylinder by small coil springs or curved flat springs, placed back of the packing rings, in place of a bull ring, or in some cases a long flat spring is shaped and put in extending all the way around the piston. Sometimes the packing rings are made in sections dovetailed together, being held out against the cylinder wall by these long springs surrounding the piston, or spiral springs are supplied to hold out each

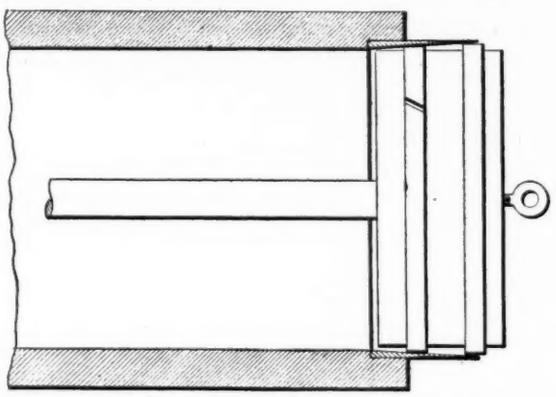


FIG. 6. PUTTING A PISTON IN A CYLINDER

section. The rings are generally prevented from turning on the piston by dowel pins set in the piston extended through the joint in the packing rings.

Broken spring rings or rings not properly fitting the grooves in the piston will cause a clicking noise in the cylinder. Broken rings cause the cylinder to wear rapidly and may score the surface of the cylinder sufficiently to require its reboring. Loose-fitting rings allow the steam to escape past each side and under the ring.

Testing Storage Batteries

By L. W. Webb

The most important storage-battery tests are as follows: (a) The cadmium test, (b) the acid tests, (c) the specific-gravity and voltage tests, (d) the ground or leakage test, (e) the discharge capacity and (f) efficiency.

The cadmium test affords a method of determining the exact condition of charge of each plate, irrespective of the terminal voltage between them. It is often found that cells showing voltages even as high as 2.5 volts on charge give very little capacity owing to the negatives not being fully charged. The cadmium test will show this up at once, and usually the negative plate will be low and require overcharging before it is finally reduced to lead sponge. The reading between cadmium and negative will thus give an indication of the capacity that can be obtained from the battery. The curves in Fig. 1 show the potential of the negative plate relative to the cadmium under normal conditions throughout the cycle of charge and discharge. The cadmium does not discharge or change, and therefore its potential line is constant and the difference between it and the negative element gives a true idea of the changes the latter is undergoing. After about seven hours of charging, the voltage between cadmium and negative falls to zero, then becomes negative. The final value reached at full charge may be as low as —0.20 volt when the plates are new and their capacity high. But it will change with age, and when it is no longer pos-

sible to obtain a voltage lower than zero, the capacity of the battery will have been reduced to about 60 per cent of normal. Unless this drop is gradual and in keeping with the guaranteed life of the battery, immediate steps should be taken to try to bring the negative plates up again by prolonged overcharge at low rates, so as to reduce all the sulphate on them. If this is not successful, the battery should be taken apart and

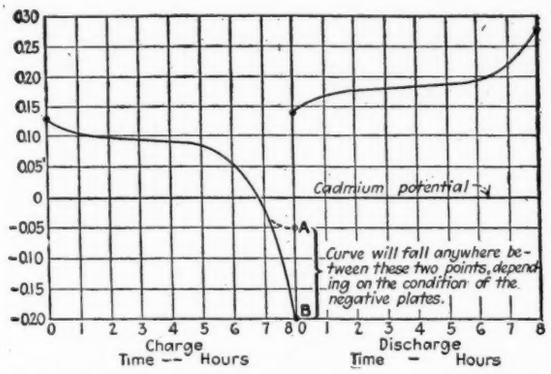


FIG. 1. APPROXIMATE VARIATION OF VOLTAGE BETWEEN CADMIUM AND NEGATIVE THROUGHOUT CYCLE OF CHARGE AND DISCHARGE

Note that these values are approximate, and many variations therefrom may be encountered in practice. However, the curves give very closely the relation between voltage readings at different points of the cycle.

careful inspection made of the positive elements for loss of active material and of the negative elements for local action.

Fig. 2 gives approximately the final voltage obtainable after continued overcharge between the negative and cadmium electrodes at different stages of the life of the battery. Theoretically, the life of the battery is totally expended when it is impossible to reduce the sulphate on the negative plate. The voltage from negative to cadmium therefore will not change, however long the charge is continued, but will remain at the initial voltage on charge. Some engineers consider the battery of practical use until the negative plate potential cannot be lowered below that of the cadmium. As already stated, however, this corresponds to a 40 per cent drop in capacity below normal, and it is hardly advisable to operate a battery when the negative element cannot be charged down at least to —0.05 volt. If, after repeated overcharging, this voltage cannot be reached and the positive element is in good condition, it is usually considered time to change the negative element.

Testing the Electrolyte for Impurities

The acid tests can best be made by a chemist, but for general information the most common ones are given as follows:

Iron causes local action by collecting on the plates and forming a voltaic couple (especially on the negative plate) that causes current to flow at the surface of the plate and discharges that particular spot. This causes sulphate to form and reduces the capacity of the plate. As iron is one of the most common of all impurities and likely to get in the acid, especially through the water used, a test should be made from time to time for traces of it. This can be done as follows: Take a small quantity of electrolyte from the cell, place it in a glass and neutralize it with ammonia. Boil it with hydrogen peroxide and add ammonia or caustic-potash solution; iron will be indicated by a brownish red precipitate which will form at the bottom of the glass.

Platinum: Traces of this metal are indicated if gassing takes place on open circuit and continues for some time when acid is poured into a cell. Platinum causes local action. When purchased from reliable concerns making storage-battery acid, not much impurities will be found.

Chlorine usually comes from salt water getting into cells, and it is not only injurious to the plates, but also gives off gasses that are very injurious to the health. Pour a small quantity of electrolyte in a glass and add a few drops of concentrated silver nitrate solution; if a white precipitate forms, it indicates chlorine.

Nitrates: Pour a small quantity of electrolyte in a glass and add a strong solution of ferrous sulphate. Pour down the side of the glass a small amount of concentrated sulphuric acid; if nitric acid is present, it will be shown by a brown layer between the electrolyte and the concentrated acid. Nitric acid causes rapid shedding of the active material, and electrolyte containing it should never be used.

Copper: Add ammonia to a small quantity of electrolyte, and if copper is present a bluish-white precipitate is formed. Copper causes local action.

Mercury: Add lime water to a small quantity of electrolyte, and if mercury is present a black precipitate will form. Mercury often gets into acid by the breaking of thermometer bulbs. In sufficient quantities it causes local action and amalgamation.

In general, to avoid using acid containing impurities, always purchase it in the form of electrolyte from storage-battery manufacturers or else purchase chemically pure concentrated acid and make your own electrolyte by using only pure distilled water.

The Specific Gravity and Voltage Test

The specific gravity is read with a hydrometer and indicates whether the electrolyte contains the correct proportion of acid. These readings should be periodi-

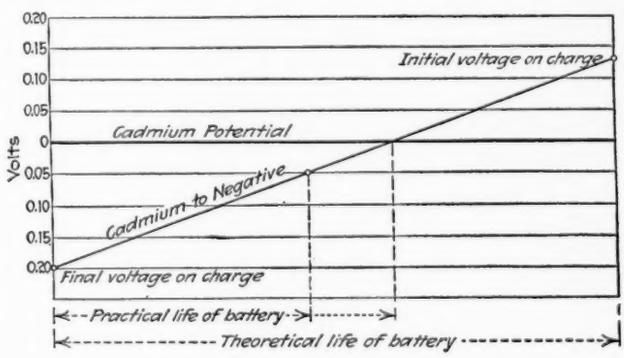


FIG. 2. VOLTAGE ATTAINABLE BETWEEN CADMIUM AND NEGATIVE AT DIFFERENT STAGES OF THE BATTERY LIFE

This curve gives an idea of the condition of the negative element. If, after prolonged overcharge, it is not possible to obtain at least—0.05 volt between cadmium and negative, the practical life of the negative element is expended.

cally taken on all cells while charging, to see if the different cells are the same; if not, they will not charge or discharge uniformly. As the capacity of the entire battery is dependent upon that of the lowest cell, it is very important that all be at practically the same specific gravity. Overcharge should bring up a low cell. Otherwise, some electrolyte may be added until it is right. Allow plenty of time for the electrolyte

to mix thoroughly before the reading is taken. When the specific gravity is too high, remove a little electrolyte and replace it by pure distilled water, a small quantity at a time, until a correct reading is obtained. Voltage tests indicate low cells very quickly. All readings should be taken *while current is flowing* and *never on open circuit.*

The ground or leakage test is usually made with a voltmeter and consists in grounding one of the voltmeter leads and touching the battery terminals with the other to see whether reading is obtained, Fig. 3. If a

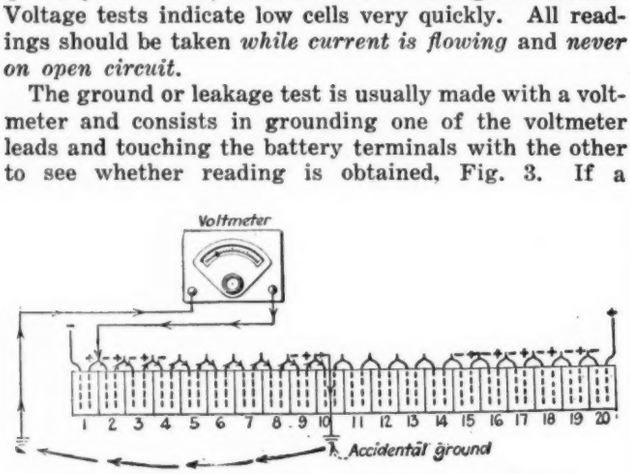


FIG. 3. GROUND TEST ON STORAGE BATTERY

Ground one lead of a voltmeter and touch the battery terminals in turn with the other lead. If there is a deflection, the battery is grounded. The grounded cell is indicated by the smallest deflection on the instrument.

deflection is observed, it indicates a ground. If there is more than one ground, the battery will discharge through them (the amount depending on the resistance of the grounds) and thus reduce the capacity of the whole battery by causing low cells. Grounds should be located and corrected as soon as possible. They can be easily located by the readings on the voltmeter, by moving from terminal to terminal until the lowest reading is obtained. This will indicate the grounded cell. One or more grounds can be located in this way. Grounds are usually caused by acid spraying or slopping out of cells while charging, or leaky jars, etc. They can be eliminated by wiping off the bottom and sides of jars with clear water and waste and replacing leaky jars by new ones. Acid-soaked wiring and insulation should be renewed if cleaning and reinsulation does not remove all the trouble.

Discharge Capacity

The discharge capacity varies with the rate at which the discharge takes place. The normal rate is usually on an eight-hour basis. By discharging at lower than the normal rate, more capacity will be obtained, and less capacity when higher rate is used. This does not mean any great change in efficiency, as the greater the output the greater will have to be the next charge; but it does mean that a greater output per charge will be obtained at lower than at higher than normal current rates. As an illustration of this point, a battery rated at 100 ampere-hours on the eight-hour basis would give approximately 120 ampere-hours on a twelve-hour basis and only about 65 ampere-hours on a one-hour basis.

The efficiency of a battery is the capacity output divided by the capacity input. The efficiency is practically the same regardless of the rate at which discharge takes place, for, as already mentioned, if you discharge at a high rate and get less capacity, you will not have to put as much back on the next charge as if the discharge had been at a slower rate. The efficiency averages from 75 to 85 per cent, depending on the service the battery is used on, whether it is charged immediately after discharge, whether the discharge is intermittent or continuous, etc. The main losses in a battery are I^2R losses and gassing at end of charge. The I^2R losses vary with the amount of charging current and the internal resistance of the cell.

Gassing at the end of the charge is a loss, because the electrical energy is used up in decomposing the electrolyte instead of the active material of the elements, owing to the fact that the electrolyte is not able to take up the sulphate from the plates as fast as the current rate demands. Other losses result from local action and polarization or counter-electromotive force.

Local action is caused by metallic impurities either originally in the acid or later penetrating into the electrolyte. These are decomposed into pure metal during the charge and attach themselves to the negative plate, forming in themselves a battery whose circuit is closed. This discharges a portion of the negative plate and causes sulphate to form, tending to reduce the capacity of the whole battery. If this is allowed to continue too long, the battery will become so badly sulphated that it will give practically no capacity. Acid should be tested for impurities at the first sign of loss of capacity, beyond the allowable depreciation for age or excessive accumulation of sulphate on plates which is not worked off during charge.

Polarization or counter-electromotive force is caused by hydrogen gas collecting at the negative electrode and setting up a counter voltage or electromotive force opposing the current flow. On discharge, it causes a voltage drop at the battery terminals greater than that which would be caused by the internal resistance of the cell alone (which as a rule is very small) and acts as an apparent increase of internal resistance.

Water-Works Pumping Plant for the City of Regina, Saskatchewan

By C. O. Thomas

The city of Regina, Saskatchewan, Canada, installed in 1916 a pumping set having some interesting features from the standpoint of water-works practice. Originally, the equipment was specified to consist of a triple-expansion or compound engine driving two centrifugal pumps, but it was found to be almost impossible, on account of the war, to obtain a set of this type. For this reason and also because the water supply from deep wells at a temperature of 45 deg. F. was available for condensing purposes, it was decided to use two centrifugal pumps driven by steam turbine through reduction gearing. A front elevation of the actual installation is shown in the figure.

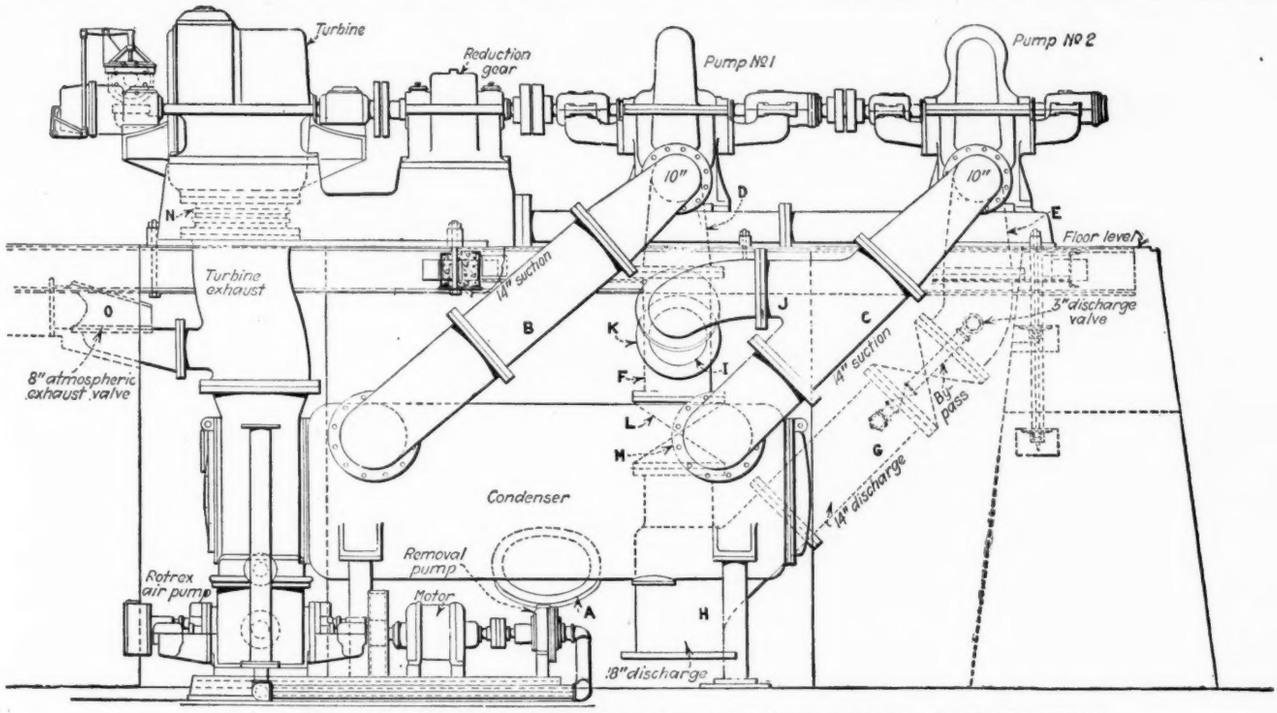
As will be seen from the elevation, the two pumps are driven in tandem and draw the whole volume of water through the surface condenser below, which is of the "water-works" type. The water circulates outside the brass tubes and the exhaust steam inside. Under the parallel operating condition, which is the normal one, the water to be pumped is sucked into the condenser through an 18-in. inlet *A*. The condenser acts as a tee piece, and the flow divides into two 14-in. suction pipes *B* and *C*, tapering in the elbows to 10 in. at the pumps. The two 10-in. discharge nozzles of the pumps deliver through taper elbows *D* and *E* into 14-in. pipes *F* and *G*, which again unite in the 18-in. lateral *H*. When operating in parallel in the manner just described, the pumps have a combined normal capacity of 8,400,000 U.S. gal. per day (equal to 5,832 U.S. gal.

per minute) at a head of 150 ft., including 13 ft. of suction consisting of vertical lift and loss of head through the condenser. The pumps can carry an overload of 25 per cent.

In the event of a fire breaking out and a higher pressure being required in the city mains, the pumps can be quickly converted to operation in series. Under this condition the quantity of water delivered at normal rating is, of course, reduced by one-half, but the head is increased to a little less than 300 feet. For series operation the valve *L*, regulating the discharge of pump No. 1 to *H*, is closed and the valve *K* is opened so that the discharge from pump No. 1 is carried into the suction pipe *C* of pump No. 2 by the cross-over pipe *I* and

The double-reduction gearing has a ratio of about two to one. The gear case is bolted down to an extension of the turbine bedplate, and the gearing and turbine are supplied with forced lubrication from a geared pump through an oil cooler. Flexible couplings are fitted at each end of the gear set and between the two pumps.

The absence of a water box at the right-hand end of the condenser is accounted for by the fact that the water circulation takes place outside the tubes. This entails a minimum loss of head. The air and condensate are withdrawn by a wet air pump of the revolving eccentric-drum type, driven through reduction gearing by an induction motor. The latter is also directly



FRONT ELEVATION OF WATER-WORKS PUMPING PLANT, REGINA, SASKATCHEWAN

the lateral *J*. The valve *M*, through which pump No. 2 draws water from the condenser in parallel operation, is also closed in series operation. To withstand the high pressure occasioned by fire service, pump No. 2, the second in series, has its casing stiffened by external ribs.

The shaft diameter was made the same for both pumps so that only one spare shaft would be needed for the two. This diameter was, of course, determined by the torque to be transmitted between the gearing and the impeller of pump No. 1. In laying out the equipment due consideration was given to the advantage to be derived from placing the condenser close to the turbine. The necessity, however, of keeping the cross-over connection entirely below the floor line, and the space required for the long-radius elbows, compelled the location of the condenser a few feet from the turbine-exhaust outlet.

The turbine is of the multi-stage high-pressure condensing type using steam at 150 lb. pressure and 100 deg. superheat and carrying a 29-inch vacuum. The turbine speed at normal load is about 3,550 r.p.m. Exhaust takes place to the condenser through a copper corrugated expansion joint *N*, and relief to the atmosphere is provided by an automatic exhaust valve *O*.

connected to a 1-in. centrifugal pump for elevating the condensate to the feed-water tank.

As the ratio of condensing water to exhaust steam, even when the pumps are working in series, is 389 to 1, the rise of temperature of the water in the pump suction is negligible. There is, therefore, no possibility of the pumps losing their water on this account.

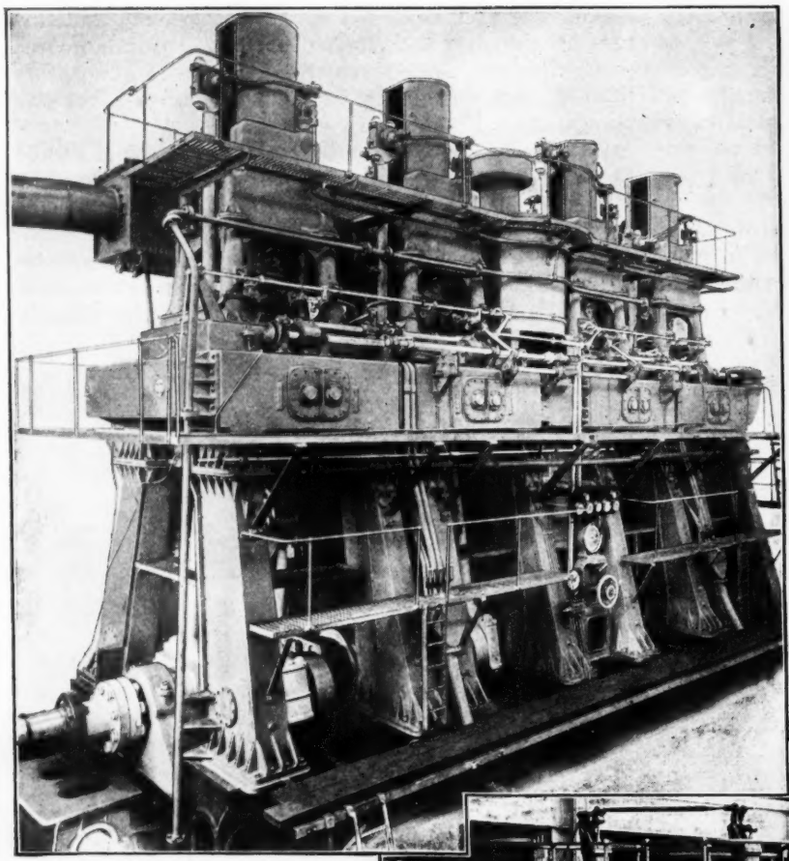
The operation of this pumping set has been satisfactory, and the guarantees given in the table fully realized. At the time the plan was worked up, a direct drive between the turbine and pumps was considered, and the duty guaranteed under this condition is also given for comparison.

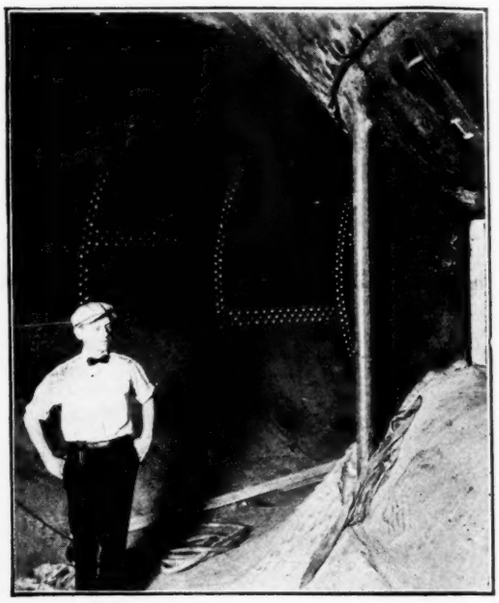
PERFORMANCE GUARANTIES

Conditions: Parallel Operation; Total head, 150 ft.; pumps run at 1,800 r.p.m. at full load; steam pressure, 150 lb.; superheat, 100 deg. F.; vacuum, 29 in. referred to 30-in. barometer.

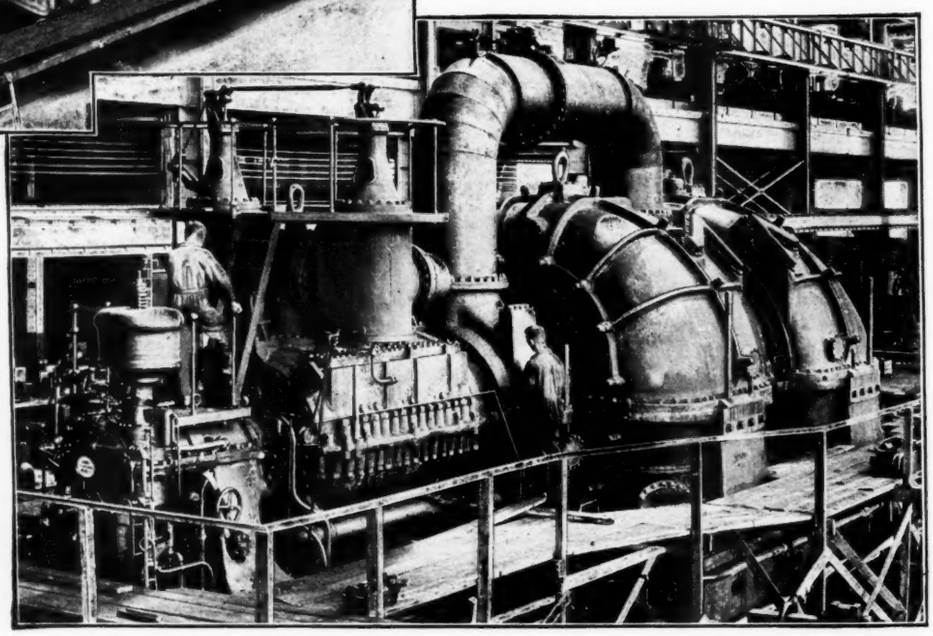
Load, per Cent of Normal	U.S. Gal. per Min.	Duty in Million Ft., Lb. per 1,000 Lb. of Steam		Steam Consumption in Lb. per Water Hp.	
		Geared	Direct Drive	Geared	Direct Drive
125	7,290	105.0	87.1	18.85	22.72
100	5,832	117.0	88.8	16.93	22.30
75	4,374	105.0	81.4	18.85	24.35
50	2,916	88.0	67.3	22.50	29.40

The contractors for the complete equipment, including inter-connecting piping, and for the erection and starting up, were Messrs. Fraser & Chalmers, of Canada, Ltd.



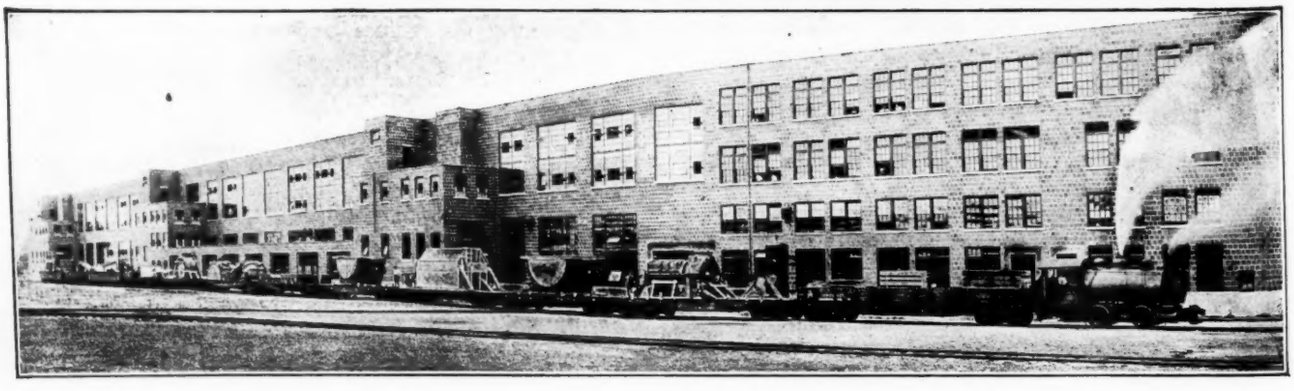


What the inside of a 37,500-hp. water turbine looks like in comparison with a man. The machine shown is unit No. 16 at the Niagara Falls Power Co.'s No. 3 plant; the photograph was taken near the entrance of the spiral casing.



An oil engine recently developed in England for marine use. It is of the semi-Diesel, two-stroke-cycle, opposed-piston type and delivers 2,600 b.h.p. at 77 r.p.m. The bore is 23 in. and the total stroke (two pistons) 91 in. By means of vertical coupling rods, one on each side of the cylinder, the upper piston drives cranks on each side of the lower piston's crank and 180 deg. from it. Ignition of the fuel oil at the unusually low compression pressure of 300 lb. per sq.in. is provided for by leaving an uncooled projection on each piston. The makers, William Doxford & Sons, plan to use it as a standard. Further facts about this engine were given in *Power* for Aug. 2.

The twelve freight cars shown below were required for shipping the turbine unit on the right, which was recently completed by the Westinghouse company and is to be installed in the new Calumet Station of the Commonwealth Edison Co. in Chicago. The machine is of the tandem-compound type and has a capacity of 35,000 kw.



EDITORIALS

Mutual Debtors

FOLLOWING immediately on the heels of the New York meeting of the American Chemical Society came the Seventh National Exposition of Chemical Industries, which was held in New York City during the week of September twelfth. Any power-plant men who were fortunate enough to attend this exhibition must have been deeply impressed with the magnitude of the chemical industries and their innumerable points of contact with daily life. The variety of materials and apparatus shown by the more than four hundred exhibitors was almost overwhelming to one who had not been in constant touch with chemical progress.

Chemistry has made many contributions to the power-plant field. We would not, of course, go so far as to give chemistry credit for our ability to burn coal and other fuels. Although combustion is essentially a chemical process, it was carried on, after a crude fashion to be sure, for centuries without the aid of chemical knowledge. It must be admitted, however, that modern furnace designs and modern methods of operation could hardly have been developed without some knowledge of the chemistry of combustion.

Broadly speaking, every part of the power plant is more or less indebted to chemistry, but, aside from a few such processes as the chemical tests for condenser leakage, most of the immediate and obvious uses of this science are to be found in the boiler room. The exhibition just mentioned made this very evident. Among the more notable direct uses of chemistry in the boiler room are the following: Flue-gas analysis, coal analysis, feed-water analysis and treatment and scale removal. These are a few of the direct contributions of chemistry to power-plant operation. Even more important are the *indirect* contributions in the form of suitable metals (iron, steel, bronze, babbitt metal, etc.), lubricating oils, insulating and refractory materials and so on.

The gain is not all on one side, however. The power-plant man can easily show the fundamental importance of his prime movers to all the chemical industries that have gotten beyond the test-tube scale of operations. Not only do the chemical industries, like most others, depend on the prime movers, but most of them are dependent upon process steam. It is evident that, without the power plant, chemistry would be tremendously hampered as an adjunct of civilization. It is equally evident that chemistry is now rendering a great service to power plants and promises to become almost indispensable in the near future.

The industrial situation is one that calls for broad-minded co-operation all around. While performing his own individual task to the best of his ability, it is important that each specialist try to appreciate the work that is being done in other fields and to see where the results obtained may be helpful in his own work. The field of industrial chemistry is young but amazingly fruitful. In all probability it has given to the power-plant field only a fraction of what it will some day have to offer. The quick appreciation and application of what has already been given will doubtless result in the rapid development of new chemical aids. The resulting improvement in power plants will again react favorably upon the chemical industries where fuel is one of the largest elements of cost.

Importance of Instrument Maintenance

CONDITION of power-plant equipment may be considered to be no better than that of its least reliable part. Instruments whose readings are not to be depended upon may have just as serious an effect upon the economical operation of the plant as failure to maintain properly the power-producing equipment. Where instruments are not kept in condition to give reliable readings, the attendants soon lose faith in them, which leads to carelessness in their use, and this laxity soon manifests itself in other features of operation. If an instrument is worth the cost of installing, it should be worth maintaining in condition to produce reliable records. If not, then a better policy would be to discard it entirely, since no one has any faith in its use and its presence is only a weak link in the chain of events that leads to economic operation.

It is generally recognized that a plant cannot be intelligently operated with only a pressure gage in the boiler room and a voltmeter and ammeter on the switchboard. The economy of many plants is seriously impaired by the lack of proper instruments to give the operating force the necessary information for obtaining the best results. On the other hand, in a large number of plants that are equipped with instruments to improve plant operation, many of these instruments have not been properly maintained and as a result have fallen into disuse, and the economy of the plants has suffered accordingly. This condition is not infrequently worse than a lack of instruments, since unreliable readings may lead to practices detrimental to economy.

Power-producing equipment in the plant is usually given periodic inspection and overhauling to anticipate trouble that may develop. This has come about from the fact that if any of this equipment fails, it may result in an interruption of the service. With an instrument conditions are somewhat different, excepting some few applications, in that if they do fail the plant can still be operated. But in general the trouble with most instruments is not failure to operate, but incorrect reading due to the lack of some minor adjustments. Modern instruments in most cases possess a high degree of accuracy and with fair treatment will maintain this accuracy for considerable periods. However, this does not mean that they should be neglected until they fail to operate, as an indication that something is wrong. Power-plant instruments are like any other part of the equipment—they require attention at regular intervals. Unless they receive it, the purpose for which they were installed cannot be achieved.

Hoover at Work

THAT Herbert Hoover is applying himself to his work with the true engineering spirit of quiet, thoroughgoing accomplishment is indicated by signs of reorganization in the Department of Commerce. At the time of his appointment as Secretary of Commerce Mr. Hoover stated that the Department should make itself more useful to business men by giving them the information they need in convenient form. Not only that, but it was his feeling that the Department should be a real help and even a guide to American business, rather than simply a sort of bookkeeping department of the Government.

Since his appointment he has not made much noise about his work, but the general expectation that he would get results has been borne out by occasional changes and improvements made in the department under his care. Some weeks ago it was announced that a "Survey of Current Business," comprising a number of tables, each of which summarizes an important industry, would be published monthly for the convenience of business men. More recently (as told on another page) the more or less haphazard collection of items embodied in the daily commerce reports has been abandoned in favor of a weekly magazine that is more concisely and logically arranged. Through the summer Mr. Hoover held a number of conferences in Washington with editors of trade and business publications in order to learn first-hand of the country's needs and problems.

Indications such as these, though each in itself may not be of great importance, are the outward signs of the house-cleaning that is going on inside one of the departments of the Government where the cobwebs have been allowed to gather by politically able office holders. Less politics in business does not mean that the Government cannot be of great help to American business men; and of all men, Mr. Hoover is most likely to succeed in bringing that about, and seems to be losing no time in making the effort.

Diagnosing the Disease

IF THE nature of a disease is known, means for remedying usually are readily found. Likewise, if the nature or cause of bad operation in any plant can be discovered, means for improvement are usually right at hand and readily applied.

From these statements one might think that elimination of boiler-plant troubles would be as simple as A B C. We would feel the pulse, look at the tongue and take the temperature of the plant, just as the M.D. examines his patient, and then, with appropriately colored pills or sufficiently bad-tasting medicine, proceed to remedy the ills without delay. But as every plant man knows, be he fireman, engineer or general manager, the task is anything but as simple as this.

One reason that the problem is not so simple is that a power plant, like the human body, is a complicated thing. There are involved many secondary as well as the one primary operation of burning fuel under a closed vessel which contains water. In the first place the fuel supply is itself a problem. The storage and handling of this fuel is a second consideration of no small importance. Losses of serious magnitude and depreciation in quality to a serious degree will inevitably follow from neglect of proper storage facilities. Next, the question of stoker (or burner if it be oil) presents itself; and grate and fire space demand attention. Tubes, steam spaces, superheaters and all their adjuncts represent complicated engineering problems; and too, of course, the character and handling of the ash, the operation of dozens of accessories and devices, the question of pipe and pipe covering, expansion joints and all the other details that deal with the boiler-plant itself arise even before one reaches the engine room.

The question that naturally presents itself is: What does this all mean? In the first place, it means that every part and problem in the plant should be separately studied. Keeping all but the one variable in question as nearly constant as may be, this one can be studied and the influence of changes in this variable be properly appraised.

It is a fundamental principle of research that one cannot usually study successfully more than one variable at a time. The student of boiler-plant problems must in every case observe as nearly as may be this principle, for the elimination of plant troubles really is nothing more nor less than research. Of course the plant cannot be actually taken to pieces for investigation, because unless it be assembled and all parts working together there is no means of determining just what is the effect of the single part under investigation. But in the mind of the investigator must be at all times the fact that this part is, for his purposes, as if detached. Then and then only will a clear and significant idea be had of what that part does and what changes in it mean.

Parallel Operation of Compound Generators

THERE is no more varied phase of central-station operation than trouble hunting, and no field can be found more replete with possibilities in this line than the operation of compound direct-current generators in parallel. The load distribution between the different units depends on many factors, which may be divided into non-adjustable and adjustable factors. The former class comprises the inherent characteristics of the generator and of the prime mover of each unit. In the latter class may be included brush position, series-field shunt resistance, interpole-field shunt resistance, series-field voltage drop, equalizer resistance and the governor adjustment on the prime mover, not to mention a number of additional factors when voltage regulators are used on the machines.

Most of these are more or less interrelated, and changing one will usually change one or more of the others. Thus adjusting the resistance of the series-field shunt, in order to adjust the amount of compounding from no load to full load, will change the series-field voltage drop materially. Shifting the brushes will affect the amount of compounding and commutation. Varying the governor setting will also change the compounding somewhat. The possible combinations of trouble with so many variables are many.

On page 444 in this issue will be found an article that should prove of real interest to those in charge of compound direct-current machinery. It discusses nine specific instances of trouble in parallel operation of such machines and tells of the remedy applied in each case.

CORRESPONDENCE

Advantages of the Water-Back

The editorial on page 70 of the July 12 issue of *Power*, entitled "What Do You Know About Water-backs?" opens up a number of points for discussion.

In the early days of chain-grate development the usual construction was an overhanging brick bridge wall. When this was properly built and in first-class condition, practically as good combustion efficiency could be obtained as with a water-back. The brickwork, however, did not remain in good condition for more than a few days, after which it burned away to such an extent that it was impossible to obtain high CO_2 without encountering excessive ashpit losses. Most plants having chain grates and no water-backs operated with from 6 to 9 per cent CO_2 at the damper, dependent on the immediate condition of the bridge walls, the tightness of the boiler settings and the length of fires carried. Such plants usually ran with an ashpit loss of from 4 to 7 per cent, dependent on the coal, draft and firing. The bridge-wall overhangs became ineffective in a few days and required considerable repair at intervals of from 30 to 60 days. The reasons, therefore, for the development of water-backs were the low CO_2, high ashpit losses and heavy bridge-wall maintenance that existed in the early chain-grate installations.

Early designs of water-backs, particularly those that had a separate water circulation, were subject to many troubles. Pumps that maintained the circulation might be temporarily shut down, or the water might be shut off due to carelessness or from some uncontrollable reason, in which case the water-back invariably burned. Then, there was the waste of water. A water-back operating with a temperature rise between inlet and outlet of 100 deg. F. requires approximately 30 per cent of the amount of water fed to the boiler. In condensing plants a large part of this water was wasted excepting in special cases where hot water was required in some part of the manufacturing process. In each case there was always the cost of the water, if city water was used, or the cost of pumping the water if it was obtained from other sources.

To avoid the disadvantages accompanying the old-style separate-circulation type of water-back and retain the advantages, the pressure water-back was developed. This type is connected into the boiler circulation. This at once does away with the possibility of shutting off the water supply, the cost of water for feeding water-backs, the disposal of hot water and the loss of heat. From a maintenance viewpoint this makes the water-backs no more of a problem than the maintenance of boiler tubes, and the heat imparted to the water therein increases the capacity as well as the efficiency of the boiler unit.

There was considerable experimenting in the earlier designs of pressure water-backs. Improper connections gave rise to improper circulation and resulted in warping and burning. Blowoff connections in some cases were not adequate for proper inspection and cleaning of water-back tubes and pipes, resulting in some difficulties due to burning. In the last few years, however, standards have been definitely worked out, operating instructions standardized to a point that insures satisfactory operation of the pressure water-back to the extent that if this device is given the same attention as the boiler, its service will be equally reliable, and they are now practically standard equipment with all modern installations of chain grates. They are also coming into use in connection with underfeed stokers. The advantages in this case have to do with bridge-wall maintenance, the prevention of clinker adhesions, and the free operation of dumping plates. Many plants have already made such installations some of them with plain, open-feed water-backs, although pressure water-backs have now been designed for this service.

With the traveling grate of the forced-draft type, the water-back has equal advantages. No fuel bed is sufficiently uniform to burn off in a straight line at the rear of the stoker. Therefore, in average operation it does not do to shut off the air supply at some point and figure that combustion will cease at that point. If this is done coke will pass over to the ashpit in liberal quantities. On the other hand, if some air is admitted at this portion of the fire, it will be in excess quantities through the burned-out portion of the fuel bed. Water-backs, therefore, become necessary to act as supports against which to bring the active fuel bed under draft control.

Plants with water-backs are now operating at from 12 to 14 per cent CO_2 with ashpit losses of from 2 to 4 per cent. Combustion rates per square foot of grate surface are frequently raised as much as 5 lb. per hour by making the fuel bed compact, so that the draft is effective. Water-backs have lowered the maintenance cost of brickwork; in fact, in the scores of plants that have water-backs, the difference has been so marked that this has never been an open question. Instead of repairs being necessary every 30 to 60 days, bridge-walls operate without repairs for months. Pressure water-backs, due to the advantageous position of the members, are efficient heat absorbers and actually add 2 to 4 per cent to the heat absorption of the boiler.

The advantages of the pressure water-back may be summed up as follows: (1) They furnish a support for the bridge-wall overhang; (2) they reduce maintenance on the exposed face of the bridge-wall; (3) they prevent clinker adhesions; (4) they add efficient heating surface to the boiler; (5) they retain the coke and let the ash pass to the ashpit; (6) more important than all—they permit a compressed fuel bed to be carried, so that high CO_2 and high efficiency can be obtained.

It is to be hoped that the editorial will bring out many experiences and discussions regarding this interesting functional member in furnace design.

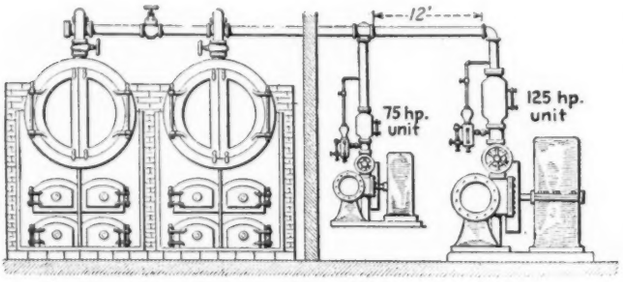
East Chicago, Ind. T. A. MARSH.

Is Scratching Sound Due to Faulty Lubrication?

In my plant I have a lubricating problem that is puzzling. There is a 75- and a 125-hp. engine, the former running at 277 r.p.m. and the latter at 375 r.p.m. The smaller engine is of the same make as the large one and is operating without any trouble. The larger engine has a scratching sound, apparently in the cylinder, which suggests that the cylinder is not getting proper lubrication with a load of 30 amperes or less. With a load in excess of 30 amperes the scratching ceases.

Each boiler is equipped with a 20-ft. 4-in. dry pipe and the pressure is 100 lb. The sketch shows the piping layout from the boiler to the engines. There is 12 ft. less piping to the small engine than there is to the large engine. The question is: Is the large engine getting proper lubrication? Both units are directly connected to generators, and it is suggested that the scratching is really at the brushes and commutator and that it is transmitted to the cylinder, but the sound is most marked at the cylinder.

I took charge of this plant in August, 1920. The engine was in the same condition then. The valve and cylinder have been examined, a new valve ring and a



PIPING BETWEEN BOILERS AND ENGINES

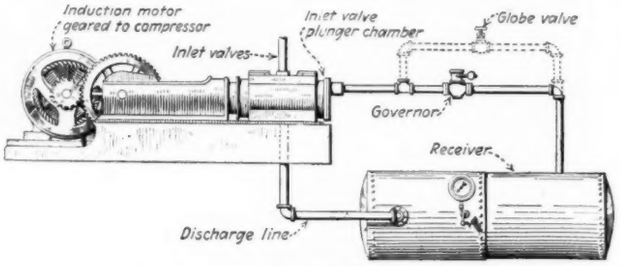
set of new piston rings have been put in. Several grades of cylinder oil, mixed flake graphite and cylinder oil, pumped into the cylinder with a hand pump have been used, but the scratching is just the same on a light load. From all accounts this engine has had a tendency to act this way ever since it was installed new in 1914.

Perhaps some reader of *Power* can advise as to what is the real trouble and if the lubrication would not be more satisfactory farther away from the cylinder. Would it be good practice to pipe the lubricator entrance to discharge the oil above the separator?

Blue Hill, Neb. JOHN S. HOLMQUIST.

Piping for Air Compressor

Certain motor- or belt-driven compressors are so designed that when the pressure in the receiver tank reaches a predetermined value, the tension of a spring in the governor is overcome and the receiver pressure is admitted to the plungers located in the compressor cylinder head. This action forces a small pin between



DOTTED LINES SHOW GOVERNOR BYPASS

the inlet valves and their seats, holding the valves open, and the compressor runs idle, merely drawing air into the cylinder and pumping it out again to the atmosphere. This arrangement of piping is shown in the sketch by the solid lines.

Oftentimes it is required to start up this kind of machine while there is pressure in the receiver tank without exhausting such pressure, and inasmuch as the common squirrel-cage motor will not supply a high starting torque, some provision must be made to unload the compressor during the starting period.

This can be accomplished by arranging a pipe as shown by the dotted lines to bypass the governor. This line, controlled by a globe valve, permits the receiver pressure to flow into the inlet-valve plunger chamber and holds the inlet valves open until the motor has accelerated to full speed. The attendant then closes the globe valve in the bypass and the compressor goes on at its normal work.

I tried out this idea and it gave satisfactory service. This type of machine is handy as well as economical either in the small plant, where it may be belted to a lineshaft, or in a large plant as a standby to help out larger machines on a heavy demand for air.

Williamsburg, Pa. W. H. STEELE.

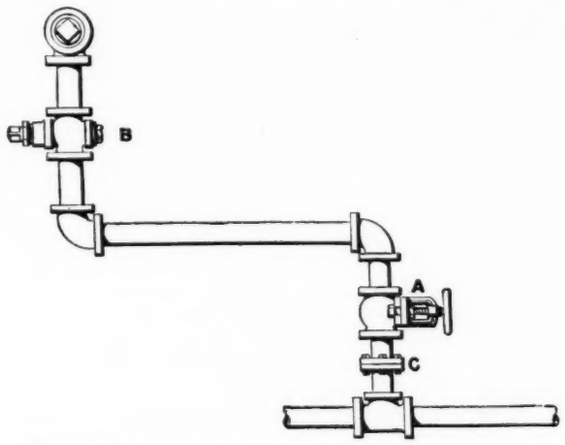
Opening and Closing the Blowoff

A pair of return-tubular boilers in my plant are fitted with blowoff pipes and valves as follows: The first nipple is screwed through the reinforcing plate until it is practically flush on the inside of the boiler. This is followed by an ell and a horizontal pipe that extends through the brick wall of the setting. There is a tee on the end of this, as shown in the illustration. By removing the plug once each year, it is possible to observe the condition of the pipe. Following the vertical nipple there is an asbestos-packed plug cock *B*, with other fittings as shown. A 175-lb. pressure gate valve is a part of the equipment, with a flange union below it.

These boilers are blown down once each day as follows: The gate valve is opened wide. The asbestos-packed plug cock is then slowly opened to its full capacity. When the desired quantity of water has escaped, *B* is closed, and then the gate valve is shut tight.

A few days ago I disconnected the flange *C* and examined the valve for leakage. Not a drop of water passed through it with 90 lb. pressure on the boiler. I have used this combination, strictly observing the foregoing rule, for 19 years.

Sometimes the cock *B* will leak around the plug, out through the gland, but not through the pipe. By removing the gland, putting a gasket of ⅜-in. asbestos wicking around the plug, and replacing the gland, the



BOTH COCK AND VALVE ARE STRAIGHT-WAY

leak is stopped. No other repairs have been required for the time mentioned, and the last internal inspection showed the parts to be in condition.

The valve *B* is located next to the boiler and is used as described, because it is made of iron, hence it will withstand friction better than a brass valve. By locating the gate valve in a vertical pipe it is impossible for sediment to collect below the gate and prevent it from closing tight. By operating it as described, there is no wear on the brass valve, hence it will last indefinitely.

When at last it may leak, it is time to replace it with a new valve of the same kind. Both valves shown afford a straight passage for water and sediment. All piping used is extra-heavy. W. H. WAKEMAN.

New Haven, Conn.

Lubrication and Molecular Attractions of Contact

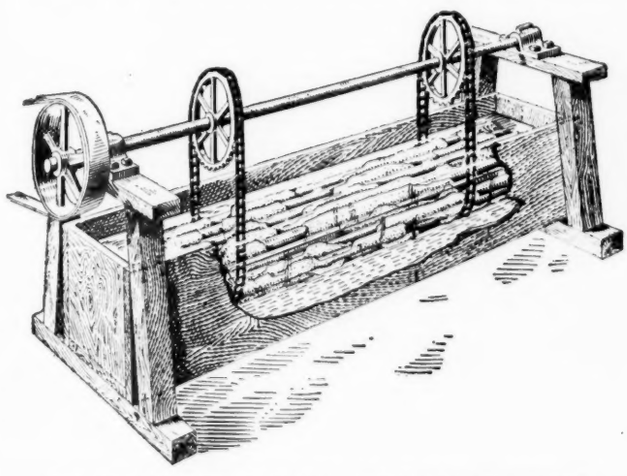
Referring to the article on page 408, in the March 8 issue, "Molecular Attractions of Contact," and to the experience of Adolph Quadt, detailed on page 111 of the July 19 issue, a similar trouble was once experienced with the intermediate-pressure crankpin bearing on a four-cylinder triple-expansion marine engine. These crankpins were made of high-grade steel with hollow centers, about eight inches in diameter, revolving at about 325 r.p.m. under normal cruising speeds. On the first trip a pound was noticed and traced to this crankpin, so it was decided to take the bearing down to ascertain the condition of the brasses and pin before keying up. The pin was found to be highly polished and resembled a French glass mirror for smoothness; the babbitt of the boxes was also exceptionally smooth and the oil channels were of ample capacity. Leads were taken and the pin connected up once more. On the next run the pin continued to heat up. It was disconnected once more and found to be in first-class condition, showing no signs of dragging the babbitt metal. The chief engineer then suggested that we give the brasses the "bastard-file treatment."

This was done, using a half-round bastard file, drawn diagonally across the babbitt metal of the brasses, leaving impressions to the full depth of the file teeth, after which the burrs and rough edges were treated with a bearing scraper; the pin was left as found, highly polished. It was again connected up, and the connection bolts set up to the same marks as previously. The bearing has given no more trouble, though the oil supply has been greatly reduced. In my opinion the best method of applying the file treatment when possible, is to the babbitt metal of the brasses rather than to the shaft. The cuts made by the file form a spiral of grooves running diagonally across the bearing, forming many small channels feeding from the main oilways, the oil being held permanently in these recesses, thus forming a continuous film. ROBERT H. LARKIN.

New London, Conn.

Cleaning Scale From Boiler Tubes

At a logging camp we had three old locomotives to haul logs from the woods to the railroad siding. As the tubes were all leaking in the firebox end until it was impossible to keep up steam, something had to be done. In a small shop used in connection with the tram road there were a lathe, a forge and a small planer. The foreman decided to remove all the boiler tubes, cut off the ends and weld on new ends, as rolling had been resorted to until the tubes were about as thin as tin. When the boilermaker began to take out the tubes, they were so scaled that it was difficult to remove them through the large tube hole in the smokebox end, which



RIG FOR REMOVING SCALE FROM BOILER TUBES

is for that purpose. As the tubes came out of the boilers, they looked more like concrete posts than boiler tubes.

Labor was scarce and demanded a fancy wage, and to clean those tubes by hand with hammers and scrapers would have required much time and would have been expensive. So the foreman had the carpenter build a watertight box, 3 ft. wide, 3 ft. deep and 14 ft. long. Two A-frames were built from 6 x 6-in. timbers and bolted together to straddle the box, the top being about 8 ft. from the ground. The top cross-pieces were 4 x 8 in., to each of which was bolted a bearing to carry a

shaft on which a belt pulley and two sprocket wheels were mounted. The rig was set up just outside the shop and belted to a shaft in the shop. The sprocket chains came down nearly to the bottom of the box, forming an endless chain. From 25 to 30 two-in. tubes 12 ft. long were put in the chains at a time. The box was filled with water from a supply tank near-by. By opening a valve slightly, a continuous stream of water was fed to the box. In operation the chains rolled the tubes, causing them to tumble against one another, thus knocking off the scale.

About one hundred tubes could be cleaned in a day with this rig. It took but a couple of hours a day for labor to remove the clean tubes and replace them with scaly ones. There was no fuel cost. Of course this may seem to some to be a crude way to clean boiler tubes, but we were in the woods a hundred miles from any shop and the rig saved the logging company about three hundred dollars. The tubes were cleaner and brighter when taken from the chains than any I have ever seen that were cleaned by hand. I do not know that the idea is a new one, but I have never seen it tried elsewhere.

Jacksonville, Fla. FRED E. CUPPER.

Discharge-Pipe Connections to Centrifugal Pump

The discussion as to the relation of the discharge of a centrifugal pump to the discharge pressure and the effect on the prime mover of a change in the friction of the discharge line, bought to mind an incident that shows clearly the working of the laws so ably stated by G. E. Miles in his letter of July 26.

In a certain plant there was a turbo-driven two-stage hotwell pump handling the condensate from a 2,000-kw. turbine. This pump discharged the condensate overboard, the end of the discharge line being five feet below the center line of the pump. After years of service this pump began to give trouble by not handling the condensate after the load had reached 1,600 kw. The speed of the pump was first tested in an effort to locate the trouble, but it was found correct. Then the failure of condenser tubes was blamed, but tests on the condensate showed that it contained from 1½ to 2 grains per gallon. Finally, the pump was opened and the trouble was found. Both impellers were badly eroded at both ends of the vanes, and the first-stage diffuser vanes were badly eroded at the tips.

An order for two new impellers and a diffuser section was sent to the manufacturers, but the best they would promise was delivery in four months. The winter load was approaching, and to make matters more complicated for the operating crew, orders were received to connect this pump to an open feed-water heater that had been recently installed in the plant. As the inlet to this heater was eight feet above the center line of the pump, the head on the discharge of the pump would be increased by thirteen feet by making this connection. The effect of this on the pump, which already could not carry its load, would be disastrous so far as carrying a good load on the turbine was concerned.

In studying the situation, it was found that the discharge line of the pump was needlessly complicated, there being fourteen right-angle turns, a turbine water meter and a globe valve in the line. It was at first proposed to alter this line, cutting out most of the right-angle turns, but later it was decided to install a new line to the heater. This was done, using the same size pipe as in the other line, but only one elbow, two forty-fives and a gate-valve.

With this new line and using the old impellers and diffusers this pump carried the winter's load; at one time, during a snow storm, 2,400 kw. was carried for three hours without any water showing in the hotwell glass.

This case is the opposite of Mr. Dixon's, but it shows in a practical manner that a decrease in the friction of the discharge will increase the quantity of water handled by the pump. A. L. POLLARD.

Halifax, N. S. Canada.

Does a Condenser Decrease the Load on an Engine?

On page 338 of *Power* for August 30, W. H. Wakeman says:

> We are told that if a condenser is added to a non-condensing engine the same load can be carried with less fuel. In reality the total load is less, as the condenser takes off enough back pressure to reduce the forward pressure by twelve pounds or more, hence the load is less, consequently less steam is used.

I confess that this is too deep for me. When an engineer talks about the load on an engine, he naturally means the work that it is doing including the overcoming of its own friction. The removal of the pressure of the atmosphere on the back side of the piston does not take anything from that load. It simply shifts the diagram to a lower plane with reference to the atmospheric line, if the same cutoff is used, or shortens the cutoff if the same initial pressure is used. In the first case the same volume of steam is used, but it weighs less per cylinderful on account of the lower pressure. In the second case less volume of the same pressure and density is used per stroke.

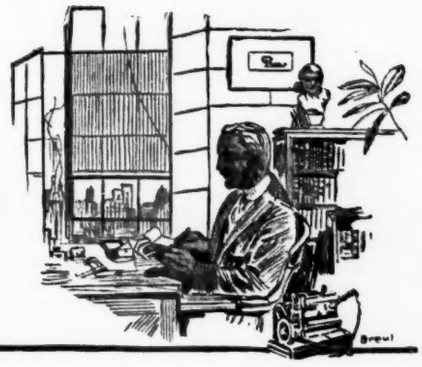
To call the pushing of the spent steam out into the atmosphere part of the load on the engine would be more confounding than any of the faults in engineering nomenclature which Mr. Wakeman criticizes.

His following paragraph regarding tables of mean pressures is misleading. Such tables are mean *absolute* pressures, not mean *effective* pressures. If the absolute back pressure is deducted, they will be as correct for non-condensing as for condensing engines. They do not profess to be precise for either, but are based on the assumption that the product of the volume and pressure is constant throughout expansion, and make no allowance for pre-release, wiredrawing clearance or compression. They are all right for what they are intended for, but must not be used beyond their limitations. R. A. LIVINGSTON.

New York City.

That the biggest field for accident-prevention work is among the younger employees was the opinion expressed in a paper on "Accident Prevention Among Electric Utilities," presented at the recent convention of the Pennsylvania Electric Association. It was pointed out that statistics compiled by the National Electric Light Association on 10,435 accidents occurring in 1919 show that 75 per cent of these accidents are attributable to employees of less than four years' service.

INQUIRIES OF GENERAL INTEREST



Tempering Steel Tools—How may drills, chisels and similar steel tools be tempered? E. D.

To temper steel it is first heated to a cherry-red heat and the part to be tempered is plunged vertically in tepid water, which renders it glass hard. The steel is then removed from the water and the cooled part is cleaned by rubbing it with a piece of sandstone. As the heat from the uncooled part flows to the part that was cooled, the hardened portion of the steel gradually becomes softer, and this softening or "drawing the temper" can be stopped at any stage by quenching the whole of the steel in the water. The order in which colors appear on the brightened surface during the process of drawing the temper is light straw, dark straw, purple, dark blue, light blue. For scrapers, drawing of the temper should be stopped by quenching when the color is yellow; for drills, punches and taps, when dark yellow; and for small tools and chisels, when dark blue.

Burning-out of Firedoor Arch—How can burning out of a firedoor arch in the flush front setting of a return-tubular boiler be prevented? W. G. M.

Disintegration of firedoor arches of flush-front settings usually results from hot furnace gases finding outlets through cracks and cavities in the front wall, directly to the uptake. To prevent this, the front wall should be built up with brickwork well bonded and grouted and there should be a good sealing off of the furnace where the front wall laps over the shell of the boiler. The best safeguard against crumbling is to provide single-span firebrick arch blocks. Where these are not obtainable, greater durability will be secured by replacing the front wall with a wall of greater thickness. This, however, requires a broader dead plate and also shorter grate bars, unless the original length of furnace is obtained by moving back the bridge wall.

Valve Setting of Double-Eccentric Corliss Engine—For a double-eccentric Corliss engine, why are the steam valves set with negative lap and the exhaust valves set line on line; and is there danger of waste by steam blowing through with this setting? W. G. P.

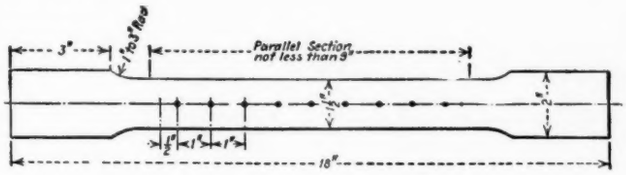
With the standard Corliss valve gear, cutoff must occur before the wristplate has completed its greatest swing to one side of its central position. If the movement of the wristplate is the same on each side of the stud, then when the wristplate moves from the central position to the limit of its travel, the crank and eccentric do not accomplish more than 90 deg. of rotation and the piston travels only about one-half of the stroke. Hence to obtain cutoff later than one-half stroke, the stroke must begin with the eccentric behind the 90-deg. position, but if the steam valves are set line on line, admission cannot occur until the wristplate comes up to the central position after the beginning of the stroke. By taking up the valve rods to obtain admission with the desired amount of lead in the beginning of the stroke, the valves will be open when the wristplate arrives at its central position; that is, the valves will have negative lap.

The exhaust valves are set line on line when the wristplate is in the central position, so each valve will be open during 180 deg. of rotation of the shaft and release in one end of the cylinder will occur simultaneously with compression of exhaust in the other end.

When the eccentric is set much back of 90 deg. for obtaining cutoff later than one-half stroke the governor must be blocked in stopping, so that in starting the steam valves will be tripped inside of the extreme range of cutoff, because the valves will not be closed by positive cutoff until some time after the beginning of the return stroke, and the same thing will occur when the engine fails to cutoff from an overload. In either case the steam will blow through. From setting back the steam valve eccentric, slower motion is imparted to the valves for opening them and this is likely to induce leakage with blowing through of steam.

Percentage of Elongation of Boiler Steel—What is meant by the percentage of elongation of boiler steel? R. S. H.

For boiler steel of ordinary thickness tension test specimens taken from the finished rolled material are prepared of the full thickness of the material as rolled and machined to the standard form and dimensions shown in the figure.



On the parallel section, which is 1½ in. wide, gage points are made one inch apart covering a distance of not less than 8 in. The ends of the specimen are pulled apart in a testing machine. When rupture has occurred, measurement is made of the amount of elongation that has taken place between two gage points originally 8 in. apart, and this elongation in inches multiplied by 100 and divided by 8 is the percentage of elongation.

Operation of 25-Cycle Transformers on 60 Cycles—Is it possible to use a single-phase 25-cycle 2,200/220-volt transformer, formerly used on a motor circuit, on a 60-cycle lighting circuit? The transformer is of the standard double-coil primary and secondary type. R. S. S.

The 25-cycle transformer in question will operate satisfactorily on 60-cycles, particularly if the windings have been series connected in both primary and secondary, and can be reconnected with the two sections in parallel in both windings. If the primary and secondary connections are left unchanged, the flux on 60 cycles will be reduced to about 41.7 per cent of the original value, whereas the parallel connection on 60 cycles will give a flux 83.4 per cent of that produced by the series connection on 25 cycles. The regulation of the transformer will not be so good on 60 cycles as on 25, but somewhat better with the parallel connection than with the series, because the greater saturation of the iron increases the reluctance of the leakage paths and lowers the leakage inductance of the winding.

Commerce Reports Are To Be Issued Weekly

The last of the *Daily Consular and Trade Reports* of the Bureau of Foreign and Domestic Commerce was issued on Aug. 31, and on Sept. 5 the first number of the new weekly series was published. The change has been under consideration for some time and is part of the general plan of reorganization being carried on in the Department of Commerce by Mr. Hoover and his associates. What opposition there has been to the change has been based mainly upon the need for prompt distribution of "spot" news, which was possible in the daily reports. Other methods are being planned, however, for the quick distribution of such urgent information, so as to eliminate the cause of this objection.

The first issue of the new report makes a favorable impression upon the reader and is in the nature of a real magazine rather than merely a collection of miscellaneous items from different parts of the world. The subject matter of the report has been classified on a commodity basis, instead of geographically, and, indeed, the same plan has been used in the reorganization of the bureau itself. Eleven divisions or departments have so far been established, and there has been placed in charge of each one a man selected from the industry involved and having a specialized knowledge and sympathetic understanding of the industry's needs and problems.

Tenth Annual Safety Congress To Be Held in Boston

Elaborate preparations have been made for the Tenth Annual Congress of the National Safety Council, which is expected to draw from all parts of the country those who are interested and active in accident prevention and similar work. The congress is to be held in the State House of Massachusetts from Sept. 26 to 30. Reduced fares for delegates have been obtained, and full preparations have been made for the entertainment of delegates and guests in Boston.

The two most important entertainment features are to be the annual ball, which is to be held Monday evening in the Copley Plaza Hotel, and the New England Shore Dinner, which will be held Thursday evening, followed by dancing and a program of entertainment. Mayor Andrew J. Peters is chairman of the reception committee, and Governor Channing H. Cox will deliver the address of welcome at the annual meeting of members on Monday morning. Following a general session on public safety and education on Monday afternoon, a team from the Bell Telephone Co. of Pennsylvania will give demonstrations in first-aid treatment. Motion pictures on various phases of accident-prevention work will be presented Tuesday, Wednesday and Thursday afternoons.

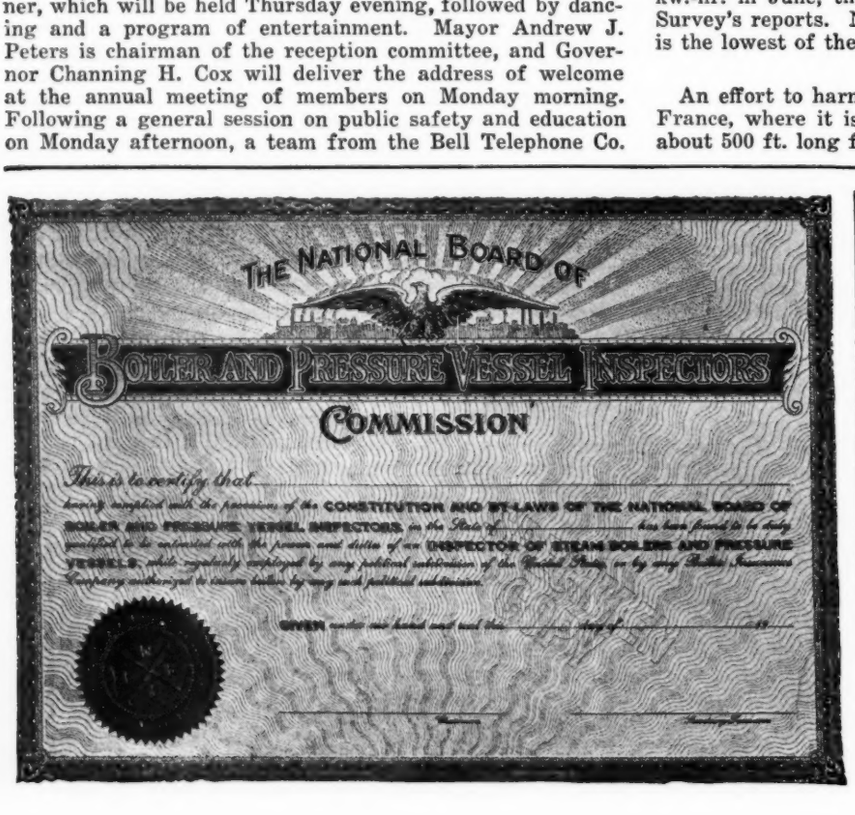
The A B C session, for those not yet familiar with safety work, will be held Tuesday afternoon, Sept. 27, under the direction of S. H. Kershaw. The session of greatest interest to *Power* readers will be held Tuesday morning by the Public Utilities Section under the direction of C. E. Morrison. Three papers are to be presented, as follows: "The Necessity of the Support of Executives in Accident Prevention Work," by Charles B. Scott, general manager of the Chicago Bureau of Safety; "Hazards in Hydro-Electric Plants," by Alex E. Bauhan, superintendent of stations of the Pennsylvania Water and Power Co., of Baltimore; "Risks in Handling and Storing Coal Oil and Byproducts," by C. E. Paige, manager of the Worcester (Mass.) Gas Light Co. Each of these papers will be discussed by two men who have been appointed for the occasion. When this session is over, there will be held a get-together luncheon at the City Club at 1 o'clock, at which a number of speakers will be heard, among them Milan R. Bump, president of the National Electric Light Association.

In connection with the congress a "No Accident Week" is to be observed throughout New England. A novel feature of the affair will be the use of the telephone to work up enthusiasm for the project. According to the *National Safety News*, every person in New England who has a telephone will be called on Monday morning, Sept. 26, to hear "The Voice with a Smile" say "Good morning, this is no-accident week. Don't get hurt."

Whistle-blowing-, bell-ringing and numerous other methods will be adopted to develop what is hoped to be the biggest safety drive that has ever been undertaken in the United States. The states involved are Massachusetts, Maine, Connecticut, New Hampshire, Vermont and Rhode Island, and it is said that the co-operation has been secured of the Governors of the states and the mayors of the various cities, as well as chambers of commerce, automobile clubs, women's organizations, churches and other such public-spirited organizations.

The mean daily output of public-utility electric plants in this country was 105,400,000 kw.-hr. in May and 107,900,000 kw.-hr. in June, the last month covered by the Geological Survey's reports. Next to that of May the June production is the lowest of the year.

An effort to harness the tides is to be made in Britanny, France, where it is planned to build an experimental dam about 500 ft. long for the development of 4,800 horsepower.


THE NATIONAL BOARD OF
BOILER AND PRESSURE VESSEL INSPECTORS
COMMISSION
This is to certify that
CONSTITUTION AND BY-LAWS OF THE NATIONAL BOARD OF
BOILER AND PRESSURE VESSEL INSPECTORS
INSPECTOR OF STEAM BOILERS AND PRESSURE
VESSELS

Uniform Boiler Inspection

Recent developments in the National Board of Boiler Inspectors comprise a provision whereby applicants for Inspector's Certificates from the National Board must have their applications approved by the Chief Inspector or equivalent official of the state from which the applicant applies. An applicant who passes a satisfactory examination and whose record satisfies the investigating committee, receives the certificate reproduced herewith, is authorized to make shop inspections and witness the stamping of boilers with the stamp indicating that they have been built in accordance with the A. S. M. E. Code; and a boiler so stamped and certified will be accepted without further stamping.

Industrial Training in Pennsylvania

A system of training industrial employees that is somewhat different from the usual plan has been developed by the Engineering Extension Division of the Pennsylvania State College, and it is said that the idea is now well past the experimental stage and is bringing good results in many parts of the state. It is felt by those in charge of the work that with the resumption of normal business activities will come an increasing interest in specialized education on account of the need that will arise of securing a large number of trained workers. It is said also that quite a number of companies are already making plans for the establishment of a broad training and educational policy as a permanent part of their business.

The system provided by the State College is a combination of a correspondence course and direct instruction and aims to secure the advantages of both without their disadvantages. When a company arranges for a course for its employees, one of its engineers or draftsmen who is familiar with the subject to be taught is appointed a supervisor, and it is from him that the students receive their personal instruction. The actual carrying on of the course, however, is attended to by the college, which gives out the textbooks and prepares and corrects examination papers. Thus the supervisor has none of the drudgery of teaching, but is free to concentrate on answering questions as they arise and to help the students on points that they find especially difficult to understand.

The supervisor meets the students as individuals rather than as a class, and arranges for certain periods each week when he is available to meet them. This may be on company time, but more often is during the noon hour or immediately after working hours. The students receive their lessons directly from the college, working them out at home and reporting to the supervisor as they need help. Completed lessons are dropped into a box provided at the shop and once or twice a week are mailed to the college for correction. The corrected papers are returned to the student with explanations, and a report on each student is sent from the college to the supervisor. This report informs the supervisor with the progress of each individual and advises as to the particular instruction each man must have to keep him up to schedule. The supervisor, therefore, is teaching students only as they require it, and takes up with each man only those things where weakness is evident.

With instruction of this kind the average student requires only a few minutes a week, with the result that the time for supervision is no greater than for class instruction. The fact that the college corrects all the papers tends to make the job of supervisor a pleasant one, and men can be obtained for it who would not be interested if they had to go through all the routine of correction. Then, too, as the college corrects thousands of papers each month, it can do it more cheaply than the company.

Another factor in the success of the plan is the textbook material that the college has prepared for shop men. The lessons were prepared after an intensive study as to requirements and cover almost every subject having a daily use in industry. Upward of thirty lesson pamphlets have been prepared and are being used not only by shops but by school boards, Young Men's Christian Association classes and other organizations having an interest in the educational welfare of the community. This lesson material is available at practically cost to any who are interested in industrial education.

Pumps and pumping machinery worth more than half a million dollars were exported by the United States during July, 1921. Mexico's share was almost four times as great in value as that of any other country. In the same month over $100,000 worth of refrigerating machinery was exported, of which Argentina received the largest share.

It is reported that plans are being made to install 70,000-hp. vertical turbines in the new addition of the Niagara Falls Power Company. These machines will operate at 107 r.p.m. under a 250-ft. head.

Boiler Inspection in California

A misunderstanding seems to have arisen among boiler users in California as a result of the repeal of Chapter 202 of the Laws of 1917, according to a recent statement from H. M. Wolflin, superintendent of safety, in which he explains the situation. The repeal was accomplished by the enactment of Chapter 904 of the Statutes of 1921, formerly known as Assembly Bill 1300.

Mr. Wolflin points out that the Workmen's Compensation Insurance and Safety Act requires that places of employment in California shall be made reasonably safe and imposes upon the Industrial Accident Commission the enforcement of the safety provisions of this law. The Boiler Safety Orders, which were adopted in accordance with the act, require the annual inspection of steam boilers operated in places of employment. Chapter 202, however, which was repealed, was enacted simply to permit the commission to charge fees for inspecting boilers, to make it illegal to operate a boiler without a permit, and to cover certain details of certification of boiler inspectors. The repeal of this chapter, therefore, will have no effect upon the Boiler Safety Orders, which will continue in effect. Amendments to the orders are being considered, but it is indicated that few important changes will be made, and that it is practically certain that the requirements for an annual inspection will remain unchanged.

Another phase of the matter is that, because of a lack of funds for safety work, it is considered unlikely that the commission's inspectors will be able to inspect all boilers annually. It is feared that this fact, together with the recent repeal of Chapter 202, may lead some boiler users to feel justified in disregarding the safety provisions of the law. With regard to this point Mr. Wolflin declares emphatically that if an explosion should occur in a boiler that had not been inspected inside of the year the owners of the boiler would still be liable to suit either by employees or by outsiders, and the fact that the boiler had not been inspected within the year would be no defense whatever.

State Board of Boiler Inspectors Planned in Pennsylvania

An effort is being made in Pennsylvania by Commissioner Connelly, of the Department of Labor and Industry, to bring about the formation of a Pennsylvania Board of Boiler and Pressure Vessel Inspectors. This organization will have no connection with the National Board of Boiler and Pressure Vessel Inspectors, but will have the somewhat similar object of promoting co-operation between the various boiler inspectors in the state, as the National Board seeks co-operation between the various states.

Letters and questionnaires have been sent out to the 800 approved boiler inspectors in Pennsylvania, including those employed by insurance and casualty companies. The response has been favorable, and it is expected that an organization meeting will be held Oct. 24, in connection with the proposed Industrial Relations Conference.

If the proposed State Board is organized, there will probably be arranged a working agreement between it and the National Board, inasmuch as the work of the two bodies is so much alike.

Diesel-electric drive is to be used on a ferryboat to be built for the Rodeo-Vallejo Ferry Co., Martinez, Cal. The vessel will have a capacity of 100 automobiles, and the installation of three Diesel engines will eliminate the usual superstructure and smokestacks, and thus leave considerably greater deck area.

New and improved machinery for the conversion of peat into fuel has been devised by a Swedish engineer, according to United States Consul-General Murphy at Stockholm. It is said that the use of peat instead of coal on locomotives has been entirely successful in Sweden.

The power division of the A.S.M.E. is the next to the largest of the twelve professional divisions, having 1,344 members.

Washington News

Report on Deschutes River Made — Department of Commerce Gathering Electrical Data — Items of Interest

BY PAUL WOOTON
Washington Correspondent

Utilization of the Deschutes River and its principal tributaries is discussed in a report recently submitted to the Federal Power Commission by the Board of Engineers, composed of: D. C. Henney, consulting engineer of the Reclamation Service (chairman); Col. J. B. Cavanaugh, Corps of Engineers, United States Army, the Division engineer for the Northwest District; and Fred Henshaw, the Geological Survey's district engineer for the Northwest. The report is voluminous, covering more than 300 typewritten pages. The recommendations of the Board of Engineers are, very briefly, that no license be issued for development of water power on either the Upper or the Lower Deschutes which is not in harmony with the maximum development of irrigation, and that no license be issued for any project on the Lower Deschutes which is not in harmony with the general scheme for the development of water power outlined in Water Supply Paper 344 of the Geological Survey until conclusive showing of an improvement upon that general scheme is made.

The Board finds that with full irrigation use in the upper and middle sections 15 power sites can be developed in the lower section with an aggregate capacity of 471,600 hp., which may be increased by 38,500 hp. through storage on Crooked River. Nine of these sites, with an aggregate capacity of 362,300 hp. without storage and 387,700 hp. with storage, can be developed at a cost of less than $140 per horsepower delivered at the mouth of the river. The Board also finds that 156,000 hp. in addition could be developed in the middle section of the river if all the waters of the river not already appropriated for irrigation, together with the reservoir sites in the upper section, were devoted to power rather than to irrigation. It concludes, however, that the general public value of 110,000 to 140,000 acres of land under cultivation would far outweigh the value of the additional power, particularly in a section of the country where undeveloped water powers are so abundant and so accessible.

The new electrical division of the Department of Commerce has begun the collection of information concerning prospective electrical construction abroad. All the available machinery of the Department of Commerce and of the State Department is being utilized in that connection. In that way, it is believed that American manufacturers can be given this information sufficiently in advance to afford them an opportunity to sell the necessary supplies and equipment.

The division is also gathering information with regard to central stations throughout the world. The data in regard to organization, equipment and the system used will be compiled.

It is the opinion of R. A. Lundquist, the head of the division, that never before in the history of the electrical industry have there been in contemplation so many projects for railway electrification. This trend toward electrification of railways has been stimulated by the high price of coal.

The meeting of the Federal Power Commission, which was scheduled for Sept. 12, was postponed owing to the fact that the Secretary of War was called out of the city. The meeting will be held immediately on his return, and the commission will then pass upon the request of the Connecticut River Power Co. for a preliminary permit covering the project at Enfield Rapids on the Connecticut River, where it is intended to develop 32,000 installed horsepower. This will be the first preliminary permit to be granted in New England since the enactment of the Water Power Act. It is expected that the commission will reject the application of A. P. Connor, of Springfield, Mass., which covers the same site.

The fifth International Mine Rescue and First Aid Meet, held under the auspices of the Bureau of Mines at St. Louis, Sept. 1, 2 and 3, proved to be the most successful event of that kind ever held. Much of the success of the affair was due to the careful preparation made in advance under the immediate direction of F. J. Bailey, assistant to the Director of the Bureau of Mines. Mr. Bailey was in official charge at the meet, which demonstrated, as never before, that the prevention of accidents has the enthusiastic support of both workers and operators. The operators and the miners each have their separate organizations to look after their own economic ends, but in the safety movement they have a common purpose and it is very evident that all concerned are giving it their most earnest support.

Reductions in pay approximating 10 per cent have been applied to the technical service of the Navy, as well as to other types of civilian employees in the Naval establishment. Some of the items recommended by the Navy Wage Board and approved by the Secretary of the Navy for the technical service are: Steel superintendents, $10,000 per year; melt-shop superintendents, $5,000; machine-shop superintendents, $5,000; heat-treatment superintendents, $5,000; forges superintendents, $5,000; senior educational advisors, $6,500; plant engineers, $5,000; powder experts, $7,500; assistant to powder experts, $3,000. In addition numerous technical positions are rated on a per diem basis.

Obituary

George C. Killeen, superintendent of the Southern New York Power and Railway Corp., Cooperstown, N. Y., and a native of Elizabeth, N. J., died recently at 46 years of age.

Personals

David P. Barrows, president of the University of California, has been appointed a member of the National Research Council for a term of three years.

Lewis A. MacArthur, general manager of the Pacific Power and Light Co., Portland, Ore., has received from the University of Oregon the honorary degree of Master of Arts in Public Service.

Henry G. Morris has been appointed by Secretary Hoover to head the new Fuel Division of the Bureau of Foreign and Domestic Commerce. Mr. Morris, who is a graduate of Massachusetts Institute of Technology and who has been working for the Government since 1917, will keep in close touch with the coal industry to ascertain the kind of official assistance that is needed.

Charles S. Crowell, who was for fifteen years district sales manager of the Underfeed Stoker Company of America, and who resigned July 1, has recently accepted a position as general sales manager with Joseph H. Roach & Co., Inc., 225 South Fifteenth St., Philadelphia.

Carl K. Chapin, formerly general manager of the Brady Utility Co., which furnishes electricity to Memphis, Tenn., is now located in Pasadena, Calif., as Southwestern editorial representative of the *Journal of Electricity and Western Industry*, a McGraw-Hill paper devoted to the progress of the West.

Society Affairs

Philadelphia Section, Association of Iron and Steel Electrical Engineers, will meet Oct. 1 to discuss "Power Distribution in Industrial Plants."

Bridgeport Section, A. S. M. E., will meet Sept. 22 at the Hotel Stratfield to hear a speech by Charles Ferguson, on "The Engineer's Part in Modern Industry."

The American Gas Association is to hold its third annual convention and exhibition in the Congress and Auditorium Hotels, Chicago, Nov. 7-12. More than 100 manufacturers will have exhibits, and the attendance of gas men is estimated at 1,500. Oscar H. Fogg is the secretary-manager and may be reached at the Gas Association offices at 130 East Fifteenth St., New York City.

Business Items

The Pioneer Rubber Mills, of San Francisco, has appointed the O. C. Keckley Co., of St. Louis, as distributor for St. Louis and vicinity of "Skookum" diagonal cross-expansion piston-rod packing.

The Westinghouse Electric International Co. has opened an office in Shanghai, which will eventually have several branches throughout the country, in order to handle inquiries and negotiations for electrical equipment. J. D. Birrell, who has been engaged in business in the Far East, is the manager of the new office.

The Andrews-Bradshaw Co. has announced that R. B. Clapp, its Cleveland district manager for the last five years, has taken over the Ohio territory with his own organization, R. B. Clapp & Co., and will continue in the Leader-News Building, Cleveland, as sales agent for makers of turbines, superheaters and other power-plant equipment.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 6, 1921	Sept. 13, 1921
Pool 1,	New York	$3.25	$3.00@3.75
Pocahontas,	Columbus	3.15	3.00@3.35
Clearfield,	Boston	1.95	1.65@2.20
Somerset,	Boston	1.75	1.45@2.00
Pittsburgh,	Pittsburgh	2.25	2.20@2.30
Kanawha,	Columbus	2.15	2.00@2.25
Hocking,	Columbus	2.15	2.00@2.25
Pittsburgh No. 8	Cleveland	2.30	2.15@2.35
Franklin, Ill.,	Chicago	2.95	2.40@3.50
Central, Ill.,	Chicago	2.40	2.00@2.75
Ind. 4th Vein,	Chicago	2.55	2.35@2.75
Standard,	St. Louis	1.85	1.85@2.00
West Ky.,	Louisville	2.35	2.25
Big Seam,	Birmingham	2.15	2.00@2.25
S. E. Ky.,	Louisville	2.35	2.00@2.25

New York—On Sept. 14, Port Arthur light oil, 22@25 deg. Baumé, 4¼c. per gal. 30@35 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

Chicago—Sept. 10, for 24@28 deg. Baumé, 40@45c. per bbl.; 32@36 deg. 1¼@1½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Sept. 12, f.o.b. refinery; Pennsylvania, 36@40 deg., 3½ to 4c. Oklahoma, 24@30 deg., 45@50c. per bbl.; gas oil, 32@34 deg., 1¼c. per gal., 36@38 deg., 1½c. 38@40 deg., 1¾c.

St. Louis—Sept. 10, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 45c. per bbl.; 26@28c. deg., 55c.; 28@30 deg., 60c.; 32@34 deg. 1¼c. per gal.

Philadelphia—On Sept. 12, 26@28 deg. Baumé, Oklahoma, 48c. per bbl.; 30@34 deg., Oklahoma (group 3) 70c. per bbl.; 16@20 deg. Seaboard, 3c. per gal.

Cincinnati—Aug. 31, for 22@28 deg. Baumé, 3c.; Diesel, 26@30 deg., 2¼c. per gal.

Cleveland—Aug. 31, for 22@28 deg. Baumé, 5c. per gal.

New Construction

PROPOSED WORK

Me., Auburn — The city, F. E. Bissbee, Chrm. of Comm., is having plans prepared for a pumping station including equipment. About $125,000. Sawyer & Bean, 11 Lisbon St., Lewiston, engrs.

Conn., New Haven—E. Malley Co., Chapel St., is having plans prepared for an addition to department store on Chapel St. About $450,000. Starrett & Van Vleck, 8 West 40th St., New York City, Archts. and Engrs.

Conn., Stafford—B. Schwanoa & Sons, Staffordville, is having plans prepared for a 1 story power house at plant. About $15,000. Private plans.

N. Y., Flushing—The Bd. Educ., 500 Park Ave., New York City, plans to build public school No. 22. About $470,000. C. B. Snyder, 28th St., Municipal Bldg., New York City, archt. and engr.

N. Y., Hammels (Far Rockaway P. O.)—The Bd. Educ., 500 Park Ave., New York City, is having plans prepared for a school here. About $300,000. Private plans.

N. Y., Maspeth—The Bd. Educ., 500 Park Ave., New York City, plans to build public school 73. About $300,000. C. B. J. Snyder, 28th St., Municipal Bldg., New York City, archt. and engr.

N. Y., New York—J. F. Oberle, 238 West 42nd St., is in the market for a 5 hp., 220 volt, direct current motor.

N. Y., Stapleton (Staten Island P. O.)—The Comr. of Docks, Room 8, Pier A, foot of Battery Pl., North River, New York City, will receive bids until Oct. 4 for furnishing and installing electric power transmission and steam heating plants, etc., on Piers 12 and 13.

N. Y., Syracuse—P. S. Andrews, First Trust Co., representing owner, plans to build an 8 story, 71 x 104 ft. physicians building on East Genesee St. About $400,000. D. R. Collin, Union Bldg., Archt. and Engr. Owner's name withheld.

N. J., Atlantic City — The Fitzgerald Hotel Co., 30 East Kentucky Ave., is having preliminary plans prepared for a 5 and 14 story hotel on Indiana and Arctic Aves. About $500,000. McLanahan & Bencker, Bellevue Court Bldg., Phila., Pa., Archts.

N. J., Englewood—The city, J. D. McKenna, Chn., Palisade Ave., plans to build a 2 story, 60 x 125 ft. city hall. About $500,000. Architect not announced.

N. J., Kearney (Arlington P. O.) — C. Presbrey, Pres. Bd. Educ., will soon award the contract for a 2 story high school on Devon St. About $800,000. Noted Jan. 4.

N. J., Rutherford—The Bd. Educ., will receive bids until Sept. 23 for a 2 story high school. About $325,000. Rasmussen & Wayland, 252 West 46th St., New York City, Archts. and Engrs. Noted Jan. 25.

N. J., Union Hill—The Capitol Theater Amusement Co., F. Hall, Pres., is having plans prepared for a 3 story, 200 x 200 ft. theater, office and stores building on Bergenline Ave. About $1,000,000. P. A. Vivanttas, 110 4th St., Archt.

Pa., Hollidaysburg — The Blair Ice & Storage Co., G. B. Miller, Pres., 1112 Allegheny Ave., recently organized, plans to build a 4 story cold storage plant. About $100,000.

Pa., Pittsburgh—The Air Reduction Co., 342 Madison Ave., New York City, is having sketches made for a 2 story oxygen plant on Ridge Ave., here. About $250,000. Francisco & Jacobus, 511 5th Ave., New York City, Archts. and Engrs.

Pa., Pittsburgh—Roland & Clark are having plans prepared for a 2 story, 50 x 100 ft. theater on 5th Ave. About $600,000. W. A. Snowoa, Empire Bldg., Archt.

Pa., Wayne — The Radnor Township School Bd., J. C. Egbert, is having plans prepared for a 3 story high school. About $300,000. H. C. Richards, 608 Chestnut St., Philadelphia, Archt.

Md., Annapolis — The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for an ash bunker, power house extension and a coal bunker for the Naval Academy from The David M. Andrew Co., Mt. Vernon Ave., Baltimore, $24,000. Hicks, Tase and Norris, 106 West Madison St., Baltimore, $24,655, and J. L. Robinson Constr. Co., 1130 West Lafayette Ave., Baltimore $25,517. Spec. 4487. Noted Aug. 23.

D. C., Washington—The National Research Council, 1201 16th St., N. W., plans to construct science hall and offices on 22nd and B Sts., N. W. About $2,000,000. Bertram Goodhue, 2 West 47th St., New York City, archt., Meyer, Strong & Jones, 101 Park Ave., New York City, engrs.

W. Va., Elkins—The city voted $125,000 bond issue for water works improvements to include pumps, motors and electrical equipment, etc. Bancroft Kress, engr.

W. Va., Huntington — The Equitable Amusement Co., c/o Meanor & Handloser, Archts., Robson-Prichard Bldg., is having plans prepared for a 3 or 6 story, 90 x 160 ft. theater, store and office building. Cost between, $300,000 and $400,000.

Ala., Overton—The Alabama Fuel and Iron Co., Prince DeBardeleben, Purch. Agt., is in the market for machinery for installation of two machine shops for mine of 2,500 tons per day, also electric motors for shops.

Fla., Jensen — The Jensen Ice Works, H. J. Schultz, Secy. and Treas., is in the market for complete machinery and equipment for the manufacture of ice.

Fla., Key West—The Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until Oct. 4 for a refrigerating plant in the United States Marine Hospital, here.

La., New Orleans—F. Schick, Ch. Engr., Hotel Grunewald, is in the market for one 220 volt. electric motor of either 30, 40, 50 or 60 hp. direct current. 600 to 1,000 r.p.m. (new or used).

O., Canton—The Continental Clay Co., 206 Zinninger Bldg., Cleveland Ave., N. J. A. Calhoun, Pres., plans to build a 10 story, 135 x 200 ft. hotel, theater and office building on 3rd and Cleveland Aves. About $1,500,000. F. Swirsky, Akron, Archt.

O., Cleveland — The Bd. Educ., F. G. Hogen, Dir., East 6th St. and Rockwell Ave., will receive bids until Oct. 24 for two 2 story, 160 x 300 ft. schools, including steam heating systems, one on East 140th St. and Darby Ave. and one on Broadview and Spring Rds. About $500,000 each. W. R. McCormack, Archt., Former bids rejected. Noted Aug. 9.

O., Cleveland—The Pythian Building Co., H. W. Thomas, Secy., Garfield Bldg., plans to build a 16 story commercial and office building including a steam heating system on East 9th St. and Superior Ave. About $4,000,000. Allen, Osborn Co., Rose Bldg., Archts.

O., Dayton—The Bd. Educ., C. J. Schmidt, Clk., is having plans prepared for a high school on Steele St. About $400,000. R. Rossell, Archt.

O., Forest—The Bd. of Trustees of Public Affairs, A. F. Barteldt, will receive bids until Sept. 23 for waterworks system including a pump building and one deep well pump with motor, etc.

O., Marion—The Marion Hotel Co., C. E. Gaurey, Mgr., is having sketches made for a 5 story hotel. About $600,000. Architect not announced.

Ind., South Bend—J. Handelman, Kimball Bldg., Chicago, Ill., owner's agent is having plans prepared for an 8 story, 150 x 175 ft. hotel including a steam heating system on Main St. and City Hall. About $600,000. J. S. Aroner & Co., 304 South Wabash Ave., Chicago, Ill., Archt. Owner's name withheld.

Mich., Detroit—Dept. Motor Transportation, c/o W. Helmboldt, Supt., City Hall, plans to build a 3 story, 200 x 350 ft. office building including a steam heating system on Russell and Alfred Sts. About $400,000. Architect not selected.

Mich., Detroit—L. Kamper, Archt., 752 Book Bldg., is preparing plans for a 3 story, 120 x 200 ft. restaurant and dance hall including a steam heating system. About $250,000. Owner's name withheld.

Ill., Chicago—A. S. Alschuler, Archt., 28 East Jackson St., is receiving bids for a 7 story addition to office building including a steam heating system at 624 North Michigan St. for H. A. Blum, 624 North Michigan St. About $600,000.

Ill., Chicago—W. W. Ahlschlager, Archt., 65 East Huron St., is receiving bids for a 12 story, 65 x 150 ft. addition to hotel on Sheridan Rd. and Wilson Ave. for The Sheridan Plaza Hotel Co. About $800,000.

Ill., Chicago—J. C. Christienson, Archt., c/o Bd. Educ., 650 South Clark St. is receiving bids for a 3 story, 188 x 277 ft. school including a steam heating system on 99th and Ave. H. About $600,000. Noted May 31.

Ill., Chicago—Churchill Hotel Corp., W. L. Ross, 80 East Jackson Blvd., is having plans prepared for a 9 story, 113 x 116 ft. hotel including a steam heating system on State and Goethe Sts. About $1,000,000. Holabird & Roche, 104 South Michigan Ave., Archts.

Ill., Chicago — Cook County Comrs., H. Zender, Comr. Public Wks., 519 County Bldg., is having plans prepared for a 3 story, 50 x 135 ft. detention home including a steam heating system on Ogden and Roosevelt Aves. About $1,000,000. E. E. Hall, 123 West Madison St., Archt.

Ill., Chicago — P. Gerhardt, Archt., 64 West Randolph St., is receiving bids for a 10 story, 90 x 104 ft. office building including a steam heating system on Milwaukee and North Aves. About $500,000. Owner's name withheld.

Ill., Chicago—Holabird & Roche, Archts., 104 South Michigan Ave., is receiving bids for an 8 story, 50 x 145 ft. film exchange including a high pressure steam heating system at 1234-6 South Wabash Ave. for Mayo Friedberg, c/o Boston Store, Chicago.

Ill., Chicago — The Illinois Merchants Trust Co., 112 West Adams St., will soon award the contract for a 21 story, 178 x 323 ft. bank and office building including a high pressure steam heating system on Jackson and Clark Sts. About $9,000,000. Graham, Anderson, Probst & White, 80 East Jackson Sts., Archts.

Ill., Chicago — The Lafayette Council, Knights of Columbus, J. E. Maloney, 1359 Devon Ave., plans to build a 4 story, 144 x 265 ft. club including a steam heating system on Fullerton and Fairfield Aves. About $300,000. Architect not selected.

Ill., Chicago—The State, c/o W. L. Sackett, Supt., 304 South Wabash Ave., is having plans prepared for a lock and power house at Dresden Island. Power plant to generate 18,000 hp. About $2,000,000. M. G. Barnes, 304 South Wabash Ave., Engr.

Ill., Moline—W. Cornwell, c/o Chamber of Commerce, plans to build a 6 story apartment including a steam heating system. About $900,000. Architect not selected.

Ill., Peoria—Dr. J. W. Parker, 519 North Monroe St., is having plans prepared for a 6 story, hotel and stores building including a steam heating system. About $300,000. F. J. Klein, 331 Main St., Archt. Noted Sept. 13.

Ill., Rock Island—The Augustana College, 38th St., c/o Dr. G. A. Anderson, Pres., plans to build a college consisting of seminary building, science hall, and dormitories for boys and girls including a steam heating system. About $400,000. Cervin & Horn, 310 Safety Bldg., Archts.

Wis., Madison—The University of Wisconsin, M. McCaffrey, Secy., will receive bids until Sept. 26 for a 1 story addition to service building and electric sub-station. About $55,000. A. Peabody, State Archt., Capitol.

Wis., Milwaukee — The Wisconsin Lutheran Synod, Rev. J. Brenner, 814 Vliet St., plans to build a seminary. About $500,000. Architect not selected.

Wis., Spring Green—The city, c/o A. Schlosse, Clk., plans to issue bonds for extension of waterworks system and probably new pumping station. About $15,000. Engr. not selected.

Wis., West De Pere — The city of De Pere, c/o Secretary of the Bd. Educ., is having plans prepared for a 2 and 3 story, 60 x 210 ft. high school including a steam heating system. About $300,000. Foeller & Schober, Green Bay, Archts.

Ia., Ames—The State Bd. of Educ., R. A. Pearson, Pres., Des Moines, c/o the Capitol, plans to build library and physics buildings. Total cost about $1,000,000. Also addition to agricultural and engineering building.

Minn., Duluth—The city plans to build a 3 story, 135x175 ft. hospital including a steam heating system on 14th Ave. West and 2nd St. About $250,000. E. K. Coe, City Hall, Engr. Architect not selected.

Kan., Lawrence—The Bd. Educ., c/o I. C. Stevenson, plans to build a 3 story high school including a steam heating system. About $500,000. Architect not selected.

S. D., Hecla—The city, c/o W. H. Higby, will soon award the contract for a power plant. About $25,000. Cory & Le Corq, Dakota Natl. Bank, Alberdeen, Engrs.

Wyo., Cheyenne—The School Bd. will receive bids until Sept 26, at the office of W. Dubois, Archt., for a 3 story, 100 x 250 ft. high school including a steam heating system on 20th and Evans Sts. About $365,-600. Noted April 26.

Mo., Portageville — The city plans to build a waterworks system including pumps, motors, etc. About $40,000. A. C. Moore, Joplin, Engr.

Mo., Sedalia — Swift & Co., c/o G. H. Trader, Local Mgr., will soon award the contract for a 2 story, 100 x 200 ft. packing plant. About $175,000. Architect not announced.

Mo., St. Louis—The Bd. Educ., c/o C. P. Mason, Secy., Bd. Educ. Bldg., will soon award the contract for a 2 story, 94x257 ft. school including a steam heating system on Kingshighway and Alabama St. About $185,000. R. M. Milligan, care of Bd. Educ., Archt.

Mo., St. Louis — A. B. Groves, Archt., Stock Exchange Bldg., will receive bids until Sept. 22 for a 7 story, 160 x 280 ft. hospital including a steam heating system on Bellview Ave. and Clayton Rd. for The Sisters of St. Mary, 1536 Papin St. About $1,000,000. Noted July 19.

Tex., San Antonio—The Masonic Lodge is having plans prepared for a 180 x 225 ft. temple. Cost between $750,000 and $1,-000,000. H. M. Greene Co., North Texas Bldg., Dallas, Archts.

Okla., Woodward — The city is having plans prepared for an addition to electric light plant. About $35,000. Black & Veatch, Mutual Bldg., Kansas City, Engrs.

Colo., Denver — The Society of Jesuits, Regis College, is having plans prepared for a 3 story, 150 x 180 ft. residence hall for college on West 50th Ave. and Lowell Blvd. About $300,000. H. J. Manning, Majestic Bldg., Archt. Noted May 10.

Utah, Salem—The city plans to build a pumping plant and distributing system. About $21,000. McGonagle & Ulrich, Desert Bank Bldg., Salt Lake City, Engr.

Wash., Seattle—The Bd. Public Wks. will receive bids until Sept. 30 for a tunnel for the George Creek plant of the Skagit River development, 1100 ft. long. About $2,000,-000. G. F. Uhden, Engr.

Wash., Seattle—The Seattle Community Apartment Co., c/o W. Bruce, Archt., Peoples Bank Bldg., plans to build an 8 story, 72 x 100 ft. apartment including a combination hot water and steam heating system on 5th and Kinnear Sts. About $380,000.

Cal., Long Beach—W. R. Krafts & Associates, 1320 Marquita St., are having plans prepared for a 6 story, 100 x 150 ft. hotel and bank building on 4th and Elm Sts. About $350,000. Wallace, Bush & Skidmore, L. A. Railway Bldg., Archts.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until Oct. 5 for boiler plant equipment. Spec. 4494. Noted Aug. 30.

Ont., Raleigh—The Township Council, A. E. Robinson, Charing Cross, is having surveys made for an electric lighting and power distribution system. About $60,000. J. N. Wilson, 190 University Ave., Toronto, Engr.

Ont., St. Catherine—The Bd. Educ., 13 Welland Ave., is having plans prepared for a 3 story collegiate and technical school including a steam heating system on Geneva St. About $600,000. S. B. Coon & Sons, 4 St. Thomas St., Toronto, Archts. Noted July 19.

Ont., Windsor—The Bd. Educ., Windsor and Walkersville Sts., is having plans prepared for a 3 story technical school including steam and ventilating system. About $600,000. D. J. Cameron, Bartlett Bldg., Archt.

CONTRACTS AWARDED

N. Y., Buffalo — The Statler Hotel Co., Washington St., has awarded the contract for power plant, boilers, Stokers, etc. for the proposed hotel on Niagara Sq. to J. W. Danforth, 70 Ellicott St. About $500,000. Noted Aug. 23.

N. Y., New York—R. H. Macy & Co., 34th St. and Bway. has awarded the contract for an 8 story factory on 35th St. and 11th Ave. to Hegeman Harris Co., 985 Madison Ave. About $300,000. Noted Aug. 23.

N. Y., New York—The Nento Bldg. Corp., 405 Bway., will build a 13 story apartment on Bway. and 90th St. About $1,200,000. Ronse & Goldstone, 512 5th Ave., Archts. and Engrs. Owners will build by day labor.

N. Y., Newtown—(Flushing P. O.)—The Bd. Educ., 500 Park Ave., has awarded the contract for a heating and ventilating system in the Newtown High School to Gillis & Geohagen, 537 West Bway., New York City, $89,434. Noted Feb. 22.

N. Y., St. George (Staten Island P. O.)—The city has awarded the contract for a sewage treatment plant and relay pumping station to the Disposal Equipment Co., 165 Bway., New York City, $79,834.

N. J., Jersey City — The State Theater Corp., F. Hall, Pres., Sinisi Bldg., has awarded the contract for a 3 story, 94 x 165 ft. theater on Hudson Blvd. to J. Mitchell, 76 Montgomery St., $400,000.

Pa., Philadelphia — Churchman, Paul & Ford, Archts., 1404 Walnut St., have awarded the contract for a 12 story, 200 x 200 ft. store and office building at 16 and Locust Sts., to Essick Constr. Co., 4345 Arch St. About $1,000,000. Owner's name withheld.

Mich., Detroit — The Bd. Educ., 1354 Broadway Ave., has awarded the contract for a 3 story, 82 x 246 ft. and 113 x 130 ft. school on Brooklyn Ave. to Otto Misch Co., 36 State St., $380,379. A Plenum steam heating system will be installed. Noted Aug. 2.

Mich., Detroit—The Detroit Loyal Order of Moose, 40 Congress St., has awarded the contract for a 3 story, 113 x 127 ft. temple on Cass Ave. and Elizabeth St. to Pine & Munnecke Co., 103 Marquette Bldg. About $500,000. A steam heating system will be installed.

Ill., Chicago — The Augustanna Hosp. Assn., 2043 Cleveland Ave., has awarded the contract for a 4 story, 79 x 106 ft. nurses home on Sedgewick and Garfield Sts. to E. P. Standberg, 111 West Washington St., $300,000. A steam heating system will be installed.

Ill., Chicago—The Bd. Educ., 650 South Clark St., has awarded the contract for a 3 story, 78 x 220 ft. school on Douglas Blvd. and Lawndale Ave. to G. E. Carson Co., 155 North Clark St. About $400,000. A steam heating system will be installed.

Ill., Chicago—The Briar Bldg. Corp., 130 North Wells St., has awarded the contract for a 9 story, 122 x 125 ft. hotel at 532-40 Briar Place to H. C. Jensen, 4948 North Hamlin Ave. About $1,500,000. A high pressure steam heating system will be installed.

Ill., Chicago—The Logan Sq. Masonic Temple Assn., c/o A. J. Donovan, 1639 South Dearborn St., has awarded the contract for a 4 story, 95 x 120 ft. masonic temple on Albany Ave. and Kedzie Blvd. to H. M. Friestedt Co., 327 South La Salle St., $300,000. A steam heating system will be installed. Noted March 15.

Ill., Chicago—S. J. Schaeffer, 155 North Clark St., has awarded the contract for a 6 story, 85 x 150 ft. apartment on Kenmore and Balmoral Aves. to Waldman Constr. Co., c/o owner, $600,000. A steam heating system will be installed. Noted Aug. 30.

Ill., Dundee — The Bd. Educ., c/o H. Haeger, Pres., has awarded the contract for a 2 story, 175 x 175 ft. high school in Kane County to C. Giertz & Son, Main St., Elgin. About $300,000.

Ill., Marshall — The State, c/o W. L. Schett, 304 South Wabash St., Chicago, has awarded the contract for locks, dam and power house and 7,000 hp. engines on Bells Island, near here, to Green & Sons, Streator, Ill. About $60,000.

Wis., Kiel—The Kiel Woodenware Co. has awarded the contract for Corliss Engine to the Nordberg Mfg. Co., Chicago and Oklahoma Sts., Milwaukee, and a 312 kva. generator to Allis Chalmers Mfg. Co., West Allis. Noted Aug. 30.

Ia., Ft. Dodge—The Bd. Educ., c/o C. A. Helsell, has awarded the contract for a 2 story, 193 x 277 ft. high school to Madsen & Peterson, Builders Exchange Bldg., Minneapolis, Minn. About $800,000.

Ia., Osklaoosa—R. F. Panders, Mgr. of Artificial Ice Co., has awarded the contract for a 2 story cold storage plant to McKey & Fanscher Co., 118 1st Ave., $55,000.

Neb., Omaha—The Bd. Educ., c/o W. E. Bourke, Secy., City Hall Bldg., has awarded the contract for a 4 story, 210 x 240 ft. high school on Burt and Cumings Sts. to F. P. Gould & Son, City Natl. Bank, $2,-297,000. Noted July 19.

S. D., Beresford—The city, W. M. Yorker, Clk., has awarded the contract for municipal power plant equipment including 285 hp. Diesel oil engine connected to 300 volt generator, to St. Paul Electric Co., 145 East 5th St., St. Paul, Minn., $35,500. Noted June 7.

S. D., Rapid City — Pennington County, c/o M. K. Steels, has awarded the contract for a 2 story court house and jail to A. Sugarman, 209 Masonic Bldg. Des Moines. About $600,000. A steam heating system will be installed.

S.. D., Sioux Falls—The J. Morrell Co. has awarded the contract for a 3 story, 100 x 140 ft. addition to cooler building to the Sioux Falls Constr. Co., Boyce Greeley Bldg. About $150,000.

Mo., Clinton—The city, c/o R. Lobaugh, Mayor, has awarded the contract for boilers to the Power Mfg. Co., Galesburg, Ill., $4,517, for electric apparatus to General Electric Co., Clinton, Mo., to be installed in the electric light plant, here. Noted Sept. 13.

Mo., Kansas City—The Bd. Educ., c/o J. B. Jackson, Secy., has awarded the contract for a 2 story school on Woodland and 8th Sts. to Collins Bros. Constr. Co., Rialto Bldg., $349,750. A steam heating system will be installed.

Mo., Kansas City—W. E. Eysell, 15th and West 10th Sts., has awarded the contract for an 11 story, 26 x 96 ft. hotel at 15 East 24th St. to Mosby-Goodrich Constr. Co., 904 New York St. About $400,000. A steam heating system will be installed.

Mo., St. Louis — The Standard Underground Cable Co., Westinghouse Bldg., Pittsburgh, Pa., has awarded the contract for a 2 story, 300 x 525 ft. manufacturing plant on Kingshighway and Slevin St. to the Widmer Eng. Co., Syndicate Trust Bldg. About $1,000.000. Cost plus percentage basis. Noted Sept. 13.

Tex., San Antonio — The Frost Natl. Bank, East Military Plaza has awarded the contract for a 12 story bank building to J. Haynes, Moore Bldg., $757,000. Heating and ventilating systems will be installed. Noted Aug. 2.

Wash., Seattle—Grunbaum Bros., 5th and Pike Sts., has awarded the contract for a 4 story, 120 x 180 ft. furniture store on 6th and Pine Sts. to Sound Constr. & Eng. Co., Lowman Bldg. About $350,000.

Que., Montreal—The Mount Royal Hotel Co., Ltd., St. Catherine St., W. has awarded the contract for a 10 story, 130 x 310 x 730 ft. hotel to Thompson & Starrett, 51 Wall St., New York City, $6,500,000. Noted March 15.

Que., Montreal—The Protestant Bd. of School Comrs., University St., has awarded the contract for a 3 story, 180 x 235 ft. school on St. Urbain St. to J. MacGregor, Ltd., 44 Closse St., $467,348.

Ont., Hamilton—The Bd. Educ., R. H. Foster, has awarded the contract for a 3 story school on Lottridge St. to W. H. Cooper, Clyde Bldg. About $300,000. A steam and mechanical ventilation system will be installed. Noted April 19.

Ont., London—The council has awarded the contract for a pump house and electrically operated equipment for sewage pumping plant to J. Hayman & Sons, 432 Wellington St., and pumps to the London Concrete Machinery Co., Cobell Ave. About $60,000.

Ont., Sarnia—The Imperial Oil Co., 115 Mitton Ave., N., has awarded the contract for a coal handling plant and hoists on the St. Clair River to Sarnia Bridge Co., 176 North St., $50,000.